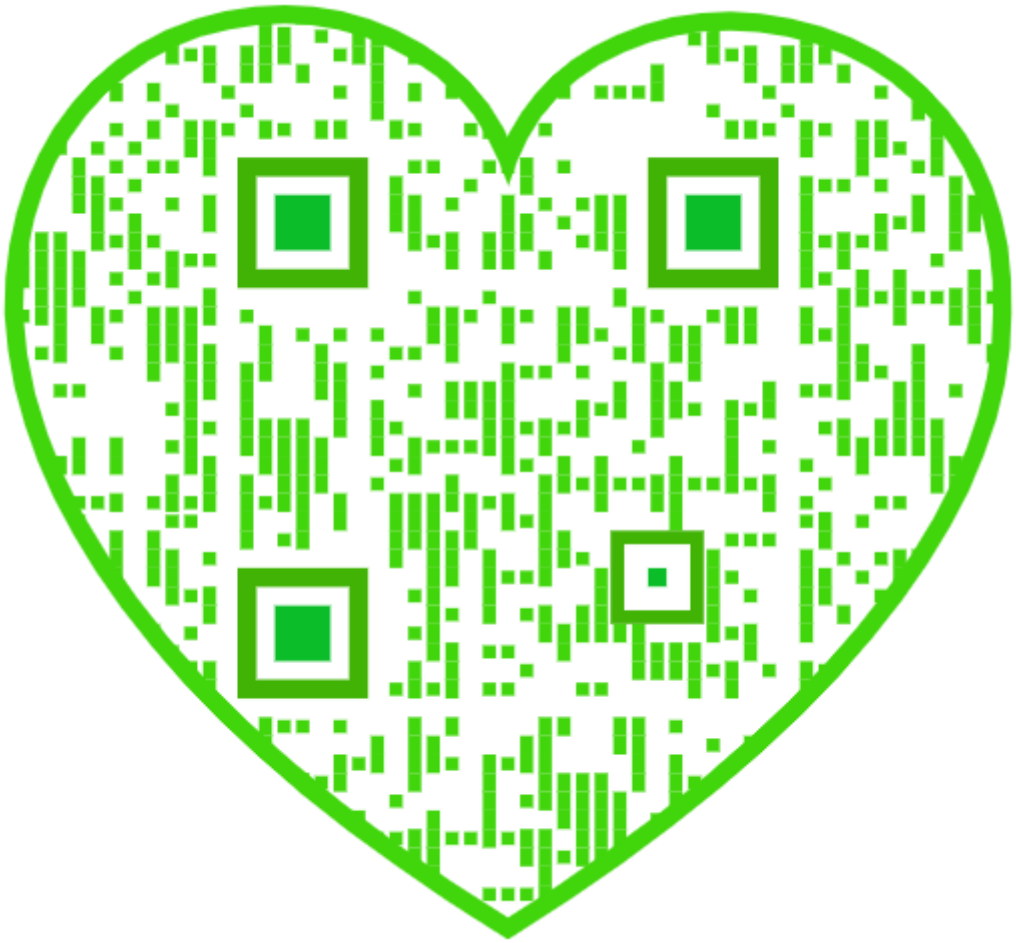

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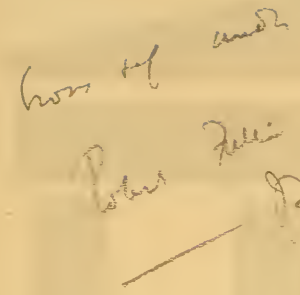

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STEAM NAVIGATION.

BY B. WOODCROFT.

STEAM Navigation, in its present practical state, owes its origin and progress to the improvements recently made in the Steam Engine in this country.

The employment of animal power in the propulsion of vessels by means of paddle-wheels is of very ancient date; and the substitution of steam for the same purpose was suggested as soon as the steam engine was rendered effective in pumping water from mines, long before it was found capable, from its then imperfect state, of propelling a vessel advantageously.

Mr. R. Stuart, in his "Anecdotes of the Steam Engine,"* informs us, that "in some very ancient manuscripts extant in the King of France's library, it is said the boats by which the Roman army under Claudius Caudex was transported into Sicily were propelled by wheels moved by oxen. And in many old military treatises, the substitution of wheels for oars is mentioned."

"Robert Valturius gives a view of two galleys moved by wheels 1472.

* Vol. i. p. 97. London, 1829.

1472. instead of oars: the first diagram shows five wheels on each side of the vessel, and the pairs are connected by a separate axle running across the boat: this axle is formed like a crank in the middle of its length, and the five axles are connected together by a rod or rope, so that all their movements are simultaneous. The second diagram exhibits one wheel at each side of the galley: these are also connected by a similar axle, as shown in figure. He supplies no details, but merely asserts that the velocity of these boats will be found greater than if propelled by oars." *

1543. "Blasco de Garay, a Spanish sea captain, exhibited to the Emperor and King Charles V., in this year, an engine by which ships and vessels of the largest size could be propelled, even in a calm, without the aid of oars and sails. The experiment was made on the 17th day of June, 1543, on a ship of 209 tons, arrived from Colibre, to discharge a cargo of wheat at Barcelona; it was called the *Trinity*, and the Captain's name was Peter de Scarza. Garay never publicly exposed the construction of his engine, but it was observed, at the time of his experiment, that it consisted of a large caldron or vessel of boiling water, and moveable wheels on each side of the ship. The speed of the vessel was a league an hour at least." †

It is worthy of remark that this account was never published till the year 1826, long after the present system of steam navigation had been established; and if such an experiment ever took place, it has been valueless to mankind, as the nature of the invention has been withheld.

To accomplish the propulsion of a boat or vessel by means of the steam engine, it is necessary that the combination of its machinery should be such as to render it applicable also to the various practical purposes for which it is now employed; and if we are to believe that such a vessel as the one here described was actually seen by the Em-

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* "De Re Militari," lib. ii. p. 2. Veronæ, 1472.

† See Scott Russell on "Steam and Steam Navigation," p. 223, and Stuart's "Anecdotes of the Steam Engine," vol. ii. p. 485.

peror Charles V. and many members of his Court, it appears extraordinary that the invention, even at so early a period, should have been allowed to sink into oblivion, and that the inventor neglected to render it useful for other purposes.* 1543.

An old English writer on military subjects says, "And furthermore you may make a boate to goe without oares or sayle, by the placing of certain wheeles on the outside of the boate, in that sort, that the armes of the wheels may goe into the water, and so turning the wheeles by some provision; and so the wheeles shall make the boate goe."† 1578.

We learn from Paucirollus, a celebrated professor at Padua in 1587, that he saw an ancient bas-relief which represented a galley with three wheels on each side, turned by three pair of oxen: and he observes that "they would have a greater velocity than the swiftest three-decked galleys."‡ 1599.

In our own country, suggestions for propelling vessels mechanically, without the aid of animal power, were made at a very early period; and the Steam Engine was named, from the use to which it was applied, "The Engine for raising Water by Fire," and patents were granted for that purpose. Among the earliest projectors on record we find the name of David Ramsey, one of the Pages of the King's Bedchamber, who with another person, on the 21st of January, in the year 1618, obtained a patent "To exercise and put in use *divers newe apt formes or kinds of Engines* and other pfitable Invencons as well to plough grounds without horse or oxen, and to make fertile as well barren peats, salts and sea sands, as inland and upland grounds within the Realmes of England, &c. As, also, to raise waters, *and to make boats for carriages runnin upon the* 1618

* For further information on De Garay's invention, the reader is referred to the works of the two authors last quoted.

† "Invention or Devises," by William Bourne, p. 15. London, 1578.

‡ "Res Memorabiles," p. 127. Ambergæ, 1599.

water as swift in calmes, and more safe in storms, then boats full sayled in great windes."

1630. Jan. 21. And on the 21st January, 1630, David Ramsey obtained a patent for himself alone, for "Divers newe wayes and Invenc̃ons by him found out and perfected, to multiply and make Saltpeter in an open field in foure acres of Ground sufficient to serve all his Mat[ies] Dominions. *To raise water from lowe pitts by fire* (the steam engine). To make any sort of Milles to goe on standing Waters by continual moc̃on without the helpe of Windes, Weight, or Horse. To make all sortes of Tapestry without any weaving loome or way ever yet in use in this kingdom. *To make Boats, Ships and Barges to goe against the Wind and Tyde*, To make the earth fertile more than usual, To raise water by a newe way, To make hard from softe, and copper to be tuffe and softe, and to make yellow Wax white very speedily."

1632. July 20. Thomas Grent, Dc̃or of Physick, obtained a patent "for several Instruments, whereof the first *is an instrument very profittable when com̃on Wynds fayle for a more speedy passage of calmed shipps or other vessells upon the Sea or great Rivers which may be called the Wynds Mãty* (mastery); the Seacond the Fish Call or a looking glasse for fishes in the Sea, very usefull for the Fishermen to call all kinde of Fishes to their Netts, Speares or Hooks, as severall calls are needfull for Fowlers to call severall kinds of Fowles or Birds to their Netts or Snares. The Third a Water Bowe, being a Manual Instrument made very serviceable for divers uses, especially for the more speedy preservation of houses upon the land and Shipps upon the sea from sudden Fire. The Fourth a Building Mould or stone press, very requisite for the building of Churches or great Houses, by which Stone Windows, Doorcases, Chimney Pieces, &c. are made more Speedilie without hewing, cutting, sawing, or ingraving, as also Brickes and Tyles more beautiful to the eye, and more durable against foule wether, being as smoothe as Glasse on the one side or end, with divers colours and workes, as if they were carved by

skilful hands and curious workmanship. The Fifte a moveable Hydraulicks or Chamber Wethercall like a cabinett, which being placed in any Roome or by a Bedside causeth sweete sleepe to those which either by hot feavers or otherwise cannot take reste, and withall altereth the dry hott Ague into a more moistening and cooling Temper, either with Musicall sounds or without. The Sixte, a Water Worke Instrument which may be called a corrected Crane, by which Wyne, Oyle, or any other liquor may be transfused from one vessell which cannot well be removed to another remote, as, alsoe water may be drawne from one place to another without any sucking or forcing by the Mouth as Vintners and other to use to doe." 1632.

Francis Lin, Gent., and two others, obtained a patent for the use and exercise upon the River of Thames, and any other River within England and Wales, "*accordinge to their own way and inveñcon the sole drawinge and workinge up of all Barges and other Vessells without the use of Horses.*" 1637.

Edward Ford, Esq., obtained a patent for "*the speedy passage and navigãcon of Boats, Barges, Lighters, and other vessells upon navigable rivers or the sea.*" 1640. March.

The Right Honourable Edward Marquisse of Worcester obtained a patent for his "several new Invenc̃ons by him invented, that is to say, an Invenc̃on to make a watch or clock without Springe or Chayne or any other kind of windage upp, but of necessity must follow if the owner or keeper of the said Watch or Clocke will know the hour of the day or night, and yet if he lay it aside severall days and weeks without looking or meddling with it shall goe very well and as iustly as most watches that ever were made. And, also, an Invenc̃on to make certain Guns or Pistols within the tenthe parte of one Minute of an houre with a Flaske contrived for that purpose. Also, an Invenc̃on to make certain Engine applyable to any coach by which a child of sixe yeares old may secure from danger all in the coach, and the coachman himselfe, though the horses become never so unruly, the child being able in the twinckling of an Eye to loosen 1661. Feb. 8.

1661. them from the coach in what posture soever they drawe or turne, be it never so short or to either hand. And, also, *an Invencon to make a Boate that roweth or letteth even against wind and streame to any part of the Compasse which way soever the streame runs or wind blows, and yet the force of the wind or streame causeth its motion,* nothing being required but a steersman, and whilst the boat stayeth to be loaded or unloaded the stream or wind shall performe such worke as any watermill or windmill is capable of."

It is clear, from the title of this patent, that the Marquis did not intend to use a steam engine to drive his boate, for he expressly says,

1663. April 3. " the force of the wind or streame causeth its motion." In this year an Act of Parliament was passed, granting to the Marquis and his successors the whole of the profits that might arise from the use of an engine described in the last article of his " Century of Invencions," on the " simple affirmation of the discovery that he had made."*

In a document written by Lord Worcester, after describing such a machine as that mentioned in his " Century of Invencions," he says, " By it, I can make a vessel, of as great burden as the river can bear, to go against stream, *which the more rapid it is, the faster it shall advance,* and the moveable part that works it, may be by one man still guided to take advantage of the stream, and yet to steer the boat to any point; and this engine is applicable to any vessel or boat whatsoever, without being, therefore, made on purpose, and worketh these effects:—*it roweth, it draweth, it driveth,* (if needs be) to pass London Bridge against the stream at low water; and a *boat laying at anchor, the engine may be used for loading or unloading.*" †

It is obvious that the Marquis did not, by this, mean a steam-propelled paddle-wheel boat, the action of which would not have been such as he describes; but a rope fastened at one end up the stream, and at the other to the axis of water wheels laying across

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* This is the engine for raising water by fire.

† Stuart, vol. i. p. 58.

the boat, and dipping into the water, so as to be turned by the wheels, would fulfil the conditions proposed of advancing the boat faster, the more rapid the stream; and when at anchor such wheels might have been applied to the other purposes.

A patent was granted to Thomas Toogood, Gent., and James Hayes, Esq., "for the sole use of an invention by them contrived and perfected, of forcing water by bellowes, not done with wind; as, also, the drawing it up with leathern bags linked together in manner of bucketts, where the bellowes cannot be placed, together with *a particular way of forcing water through the bottom or side of the Shipps, below the surface or top of the water, being for the public benefit of shipping*, drayning of mynes, bringing water to houses, emptying of Rivers or Ponds, drayning and watering of Grounds, *and which may be of singular use and ease in Navigation.*" 1661. May 16.

In 1674 another patent was granted to Thomas Toogood, Gent., and James Hayes, Esq., "for the sole use, exercise, and benefitt of several new Invencons by them found out for *the making of Shipps to saile without the assistance of Wynde or Tyde.* And, also, a certain instrument for taking the way or course of any shipp with demonstrable exactness." 1674.

And on the 17th Feb. 1675, Peter Chamberlaine, Doctor of Physick, obtained a patent "*for making several sorts of Vessells, fabricks small and greate, to navigate in a straite line with all winds though contrary.*" 1675.

Edward Bushnell, a shipwright, described "a mode of rowing ships by heaving at a capstan, useful in any ships becalmed." He connected the oars on each side the ship together, and gave them the alternate backward and forward movement by attaching the connecting pieces to ropes, which were wound and unwound by the capstan.* 1678.

In the year 1681 a book was published by the Royal Society of 1681.

* "Compleat Shipwright," p. 56, 4th edit. 1678.

1681. London, written by Denys Papin, Doctor of Physick, a French Philosopher and Mechanician, "containing, among the following suggestions, one for propelling a vessel by steam,—viz. Cookery, Voyages at Sea, Confectionary, Making of Drinks, Chemistry and Dying, with an account of the price a good big Engine will cost, and the profit it will afford."

Papin was an improver and maker of steam engines for pumping, and he proposed to apply them to the throwing of bombs; and above all, to propel a vessel against the wind, and supersede the labour of rowers and galley-slaves in ports and havens, thus allowing these persons to be employed on their proper element, the sea, instead of reposing the greater part of their time in port or on shore. He proposed to obtain a rotary motion from a reciprocating one, by employing two or three steam cylinders, the piston of one to ascend while that of the other was descending. A rack was to be attached to each piston rod, capable of taking into or being withdrawn from a pinion on a paddle-wheel shaft, so that by alternately putting one rack in gear with the pinion, and withdrawing the other, a rotary motion would be accomplished.*

During Papin's residence in England he witnessed an interesting experiment made on the Thames, in which a boat, constructed from a design of the Prince Palatine Robert, was fitted with revolving oars, or paddles, attached to the two ends of a long axle going across the boat, and which received their motion from a trundle working in a wheel turned round by horses. The velocity with which this horse-boat was impelled was so great, that it left the King's barge, manned with sixteen rowers, far astern in the race of trial.†

1682. In 1682 a horse tow-vessel was used at Chatham. It was "constructed with a wheel on each side of the vessel, connected by an

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* "Steam and Steam Navigation," p. 161; "Anecdotes of the Steam Engine," vol. i. p. 83.

† Ibid. vol. i. p. 96.

axle going across the boat, and the paddles were made to revolve by horses moving a wheel turned by a trundle fixed on the axle. It drew but four and a half feet of water, and towed the greatest ships by the help of four, six, or eight horses."* 1682.

In 1692, Anthony Duvivian, Esq., obtained a patent for his new invention, "*being a very easy and not costly machine for making a Ship go against wind and tide.*" 1692. Feb. 22.

In the year 1696, Thomas Savery, Gent., obtained a patent for his "new invention, consisting of mill work to grind and pollish looking glasses, coach glass plates, and marble stones; and, also, *for rowing of Ships with greater ease and expedition than has hitherto been done by any other.*" 1696.

This invention consisted in moving a paddle-wheel on each side of the ship, by men turning round the capstan, and thereby giving motion through ropes to the axis of the wheels.

Savery published a very interesting pamphlet on the subject of this invention in 1698, entitled "*Navigation Improved.*"

In the same year he obtained a patent for "raising of water and occasioning motion to all sorts of mills works, *by the impelling force of Fire* (steam engine), which will be of great use for draining mines, serving towns with water, and for the working of all sorts of mills where they have not the benefit of water nor constant winds." He also published a very interesting account of this his improved steam engine in 1701, entitled the "*Miner's Friend.*" By some writers on Steam Navigation, it has been alleged that Savery proposed to drive a paddle-wheeled vessel by a steam engine. In his own description of this invention, he says, "I believe it may be made very *useful* to ships, but I dare not meddle with that matter; and leave it to the judgment of those who are the best judges of maritime affairs;" and he further remarks, "As for fixing the Engines in Ships, when they 1698. July 25.

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* Savery's "Navigation Improved," p. 13. London, 1698.

1698. may be thought probably useful, I question not but we may find conveniences enough for fixing them."*

Savery would, I think, have stated in plain terms that he meant to drive a vessel by a steam engine, if such had been his intention; and so able a mechanician would have shown in what manner and by what instruments he meant to apply his steam engine for that purpose. It appears to be a proof of his sound mechanical views that he knew his engine, although doubtless the most effective of its kind at that period, to be incapable of propelling a boat advantageously.

1699. In the year 1699, M. Duquet appears to have tried revolving oars, and experiments were made with them on a large scale, both at Marseilles and at Havre: this mode, however, of impelling vessels, was soon given up as impracticable.†

1724. Feb. 26. In the year 1724, John Dickens obtained a patent for his "*new invented machine* by Floats, for raising great quantities of Water to supply Cities and Towns, to water Lands and Gardens, for draining Mines and Fenny Lands, for moving several sorts of Mill Work, *for moving Ships and other Vessels*, and for several other useful purposes."

1729. Aug. 7. In the year 1729, John Allen, Doctor of Physic, obtained a patent "for his new Invention of Heating and Boiling Water and other Liquids with far less expence than by any other method now in use, which will be of great service in working of *Engines for raising of water by Fire;* and, also, in Brewing, Distilling, and all other uses where great fires are required. And also, of his new Invention for *the application of certain powers to give motion to Engines whereby a Ship may be navigated in a calm*, from whence innumerable advantages will accrue in Sayling, and be a great preservation in Engagements at Sea; and will, also, be of great use in draining of mines, and for performing of other great works where

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* "Miner's Friend," pp. 32 and 47.

† "Recueil de Machines Approuvées par l'Académie Royal de Sciences," i. p. 173.

force is required; and likewise, of his new method to dry malt with any sort of Fuel, whereby the malt will be rendered sweeter, and the beer brewed therewith will be much more pleasant and wholesome." 1729.
"For navigating a ship in a calm" (the Doctor says in his specification) "my method will be effected by forcing water, or some other fluid, through the stern or hinder part of the ship at a convenient distance under the surface of the water into the sea, by proper engines placed within the Ship. Amongst the several and various engines I have invented for this purpose, is one of a very extraordinary nature, whose operation is owing to the explosion of gunpowder, I having found out a method of firing gunpowder in vacuo, or in a confined space whereby I can apply the whole force of it, which is inconceivably great, so as to communicate motion to a great variety of Engines, which may also be applied in working mines and other purposes."*

In 1736, Jonathan Hulls obtained a patent for "His Invention of a machine for carrying Ships and Vessels out of or into any Harbour or River against wind and tide or in a Calm." 1736. Dec. 21.

A specification of this patent was duly enrolled, together with a drawing and description of the manner in which he combined a steam engine with a boat, and with a paddle-wheel; and in what manner he converted a reciprocating retilinear motion into a continuous rotary one, to drive the paddle-wheel. Hulls' mode of obtaining a rotary motion was new and ingenious, and superior to that previously described by Papin, and was such as would enable a steam boat to be moved through the water; but it must, in candour, be admitted that it was not such as would be practically useful. He published a pamphlet on the nature of his invention in the year 1737, entitled "A Description and Draughts of a new invented Machine."

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* "Specimina Ichnographica, or a Brief Narrative of several New Inventions and Experiments." London, 1730.

1736. Many writers have fallen into error in ascribing to Hulls the discovery of the crank applied to a steam engine, so as to obtain rotary motion therefrom. This would have been in his time an important discovery, and there can be little doubt that the steam engine would then have been applied not only to propel boats, but to various other useful purposes.

In describing his mode of obtaining rotary motion by ratchet wheels, a weight, and ropes, Hulls states that he uses two axes, one behind the other, each of which is essential to the object; and he then adds, that when his "tow-boat is to be used in shallow rivers, the Machine works by two cranks fixed to the hindermost axis, to which cranks are fixed two shafts (or poles) of proper length to reach the bottom of the river, and which move alternately forward *from the motion of the wheels by which the vessel is carried on;*" so that the cranks, as described by Hulls, receive rotary motion from the axis on which they are placed, and do not, as has been erroneously stated, impart that motion to it.*

A prize being offered by the Academy of Sciences for the best essay on the manner of impelling vessels without wind, it was ob-
1752. tained by Daniel Bernouilli, who proposed inclined planes moved circularly like the sails of a wind mill: "two apparatus of this nature should be placed at each side of the Vessel, and two more behind; one of which, such as should be placed at the side of the Vessel, may be formed as follows, of a size proper for a ship of 100 guns.

"The apparatus consists of three parts—the implement for acting on the water, the frame which sustains it in its place at the side of the Vessel, and the machinery for putting it in motion. The instrument for acting on the water consists of an arbor fourteen feet long and two inches in diameter, of iron; this carries eight wheels for acting on the water, to each of which it is perpendicular, and forms an axis

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* Hulls' Specification is printed in the Repertory of Arts, vol. xii. third Series, p. 247, and in many other scientific works.

for them all; the wheels should be at equal distances from each other. 1752.
Each wheel consists of eight arms of iron, each three feet long, so that the whole diameter of the wheel is six feet; each of these arms, at the distance of twenty inches from the centre, carries a sheet iron plane (or paddle) sixteen inches square, which is inclined so as to form an angle of sixty degrees, both with the arbor and keel of the vessel, to which the arbor is placed parallel: to sustain this arbor and the wheels, two strong bars of iron of between two and three inches thick, proceed from the side of the vessel at right angles to it, about two feet and a half below the surface of the water. These bars are two and a half feet long, and five feet distant from each other." The propellers for the stern he describes to be of similar construction, but shorter, and for driving them he says, they "can be moved by men aboard the Vessels, or by Steam-Engines, or on Rivers by horses placed in the Barges."*

In 1760, J. A. Genevois, a clergyman of the Canton of Bern, 1760.
published a pamphlet in London, entitled "Some new Enquiries tending to the Improvement of Navigation."

This book contains what he calls the discovery of the "Great principle." This was to concentrate power, by whatever means produced, into a series of springs, which might be applied to various uses at the most convenient time, or in the most convenient manner.

He suggested the application of his "great principle" to the mode of propelling a vessel by oars worked with springs. He also proposed the use of an Atmospheric Steam Engine to bend the springs, which were to move the oars, and also to work a "winged cart" when the wind failed, and a "winged machine" in any wind, even a quite contrary one. His favourite project, however, appears to have been to use the expansive force of gunpowder to bend the springs of his oars. He states, that since his arrival in England he had

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* "Arm des Arts," tom. xx. "Retrospect of Philosophical, Chemical, and Agricultural Discoveries," vol. i. p. 243. London, 1806.

1760. learned that thirty years before a Scotchman proposed to make a ship sail with gunpowder, but that thirty barrels of gunpowder had scarce forwarded the ship ten miles.

Jan. 5, 1769. On the 5th of January, 1769, James Watt obtained a patent for improvements in the steam engine, one of which, namely, the "fourth," was for causing the steam to act above the piston, as well as below it, and which engine is called the "double impulse," or "double acting engine." This improvement in all cylinder engines is here mentioned in consequence of its having been the first step by which the steam engine was rendered capable of being successfully used to propel a vessel; which great improvement was applied to the first practically propelled steam boat, as will be hereafter shown, and is still used in the present system of steam navigation.

1774. In this year the Comte de Auxiron induced a number of individuals to associate for the purpose of enabling him (the Marquis) to carry his plan into execution. An experiment was tried on the Seine, near Paris, but the boat moved so slowly and irregularly that the company abandoned the scheme.

In the same year, Perier, a French engineer, who had witnessed Auxiron's experiment, made a trial on a boat with a steam engine of about one horse power, which had been laying about his shop. This engine was attached to two wheels, one on each side the vessel, with a contrivance to give them a rotary motion: the boat moved slowly, and the project was abandoned.*

1776. In 1776 an ingenious American, Mr. D. Bushnell, invented a sub-marine vessel, or diving machine, by which, when under water, "he could row upward or downward, or continue at any particular depth, with an oar placed near the top of the vessel, formed upon the principle of the screw, the axis of the oar entering the vessel, so that by turning the oar one way he raised the vessel, and by turning it the other way he depressed it." The means by which he propelled

* Stuart, vol. i. p. 282. Scott Russell, p. 238.

the vessel in a horizontal direction was by "an oar formed upon the principle of the screw, which was fixed in the fore part of the vessel, its axis entering the vessel, and being turned one way, rowed the vessel forward; but being turned the other way, rowed it backward: it was made to be turned by the hand or foot, a rudder hung to the hinder part of the vessel commanding (its course) with the greatest ease." This vessel carried a powder magazine, which could be screwed into the under part of an enemy's ship, attached to which was a kind of time-piece, which would "run any length of time under 12 hours; and when it had run out any portion of time to which it had been set, it unpinioned a strong lock, resembling a gun-lock, which gave fire to the powder." 1776.

This time-apparatus was set in motion by the sub-marine vessel leaving the magazine attached to a ship. A number of experiments were tried to blow up ships of war with this apparatus, but they all failed.*

On this day Matthew Wasborough, an Engineer of the city of Bristol, obtained a patent, the title of which clearly shows that he considered something more was wanting to make the steam engine a fit instrument to propel a ship, added to Watt's improvement of the double acting cylinder engine; namely, a practicable mode of converting a rectilinear into a continuous circular motion, for the system at this time used to obtain a circular motion from the steam engine was to employ it to raise water by pumping, and then to pass the water on to an over-shot water wheel. The title for which Wasborough obtained his patent is as follows: "Of his new invented Machine or Piece of Mechanism, which, when applied to a Steam Engine or any Perpendicular Motion, either by means of one or more levers, or any reciprocal movement, it becomes circular *without the medium of a water wheel*, which will prove of great utility to the public in the grinding of Wheat, Barley, Malt, and all other kind of grain, March 10, 1779.

* See "Repertory of Arts," vol. xv. p. 395.

1779. and in the Turning, Grinding, Rolling, Stamping, or Hammering in all kinds of mechanical operations, and adapted to the purpose of moving in a direct position any Ship or Vessel against the tide or where the wind is against the object,—or in the failure of wind, and where human or animal strength is made equal to the purpose; and which machine or piece of mechanism greatly varies from any machine or piece of mechanism hitherto invented for any of the above purposes." In his Specification the Patentee says, "First, To any Steam Engine or other Machine that hath a reciprocal or alternate movement, I apply one or more pulleys, wheels, or segments of wheels, to which are fastened ratchets, and clicks, or pulls, so contrived that while the Engine or Machine moves in a perpendicular, horizontal, or diagonal direction, that the rotative motion shall be effected. Second, Moving or shifting a wheel and its axis from one set of teeth to another. Third, Applying racks with teeth, and sometimes I make the teeth to tumble or move on their own axis. Fourth, Working from one or both ends of a working beam or great lever; and instead of a beam I substitute a wheel or pulley working by racks or chains from the piston. Fifth, I add a fly or flies to make the motion more regular. Sixth, I make my Engine above described as I find it most convenient for the purpose to which I intend to apply it. Lastly, I intend to apply my Engine, as described above, for the purpose of moving Ships, Boats, or Lighters, or any vessel on the water."

It will be observed that Wasborough's mode of obtaining circular motion differed but slightly from preceding inventions, all of which had been found impracticable; and although he applied it to a few engines, it did not act well, and was soon superseded by the invention of James Pickard, who obtained a patent in 1780, the title of which is "His new invented Mill or Machine upon an entire new construction, which will be of great advantage in various Manufactories, such as Rolling, Turning, Boring, Grinding of Corn and all other sorts of

1780. Aug. 23.

Grinding, Forging, Flattening, and Hitting of Iron, and every other work that a mill is capable of performing by a rotative motion, which he conceives will be of great public utility." 1780.

This invention is no other than the present connecting rod and crank, and a fly wheel; and here we have the second and last great improvement in the Steam Engine which enabled it to be of service in propelling vessels. Pickard entered into partnership with Wasborough, who soon introduced a number of stationary engines with the crank, from which period that motion became generally used.

In the following year, 1781, James Watt obtained another patent, the title of which is "His new invented method of applying the vibrating or reciprocating motion of Steam or Fire Engines to procure a continued Rotative or Circular Motion round an axis or centre, and thereby to give motion to the wheels of mills or other machines." 1781. Oct. 25.

This invention consisted in the sun and planet motion.

In the same year the Marquis de Jouffroy constructed a steamboat at Lyons, 140 feet in length, with which he is said to have made several successful experiments on the Saone, near that city; but owing to the French revolution, a few years afterwards, he was prevented from prosecuting his undertaking.

In the year 1785, Joseph Bramah, the inventor of the Hydraulic Press, of a Lock, and of other mechanical improvements, obtained a patent under the following title: 1785. May 9.

"His new invented Hydrostatical Machine and a Boiler on a more peculiar principle than any other yet made known to the public, in which said machine may be employed the power of air, steam, or any other elastic vapour, for the purpose of working all kinds of mechanical and other Engines; and such machine is, also, capable of becoming the primordial or first cause of motion in all kinds of inanimate movements whatsoever, and may be employed instead of pumps or any other Hydraulic Engine for the purpose of raising water through any given space, and will for that purpose be found much more

1785. effectual, durable, convenient, and less expensive than any other Engine or Pump yet known or in use."

One of the inventions described in the Specification of this patent is a mode of propelling vessels by the improved rotatory engine therein described and claimed, (which will also act as a pump,) by means either of a paddle-wheel or what may be called a "Screw Propeller."

Bramah shows a vessel with a rudder placed in the bow, and he describes the nature of his Screw Propeller and its mode of action in the following terms:

"Instead of the (paddle) wheel A, may be introduced a wheel with inclined Fans, or Wings, similar to the fly of a smoke-jack, or the vertical sails of a windmill: this wheel or fly may be fixed on the spindle C alone, and may be wholly under water, when it would by being turned round either way cause the ship to be forced backwards or forwards, as the inclination of the Fans or Wings will act as oars with equal force both ways, and their power will be in proportion to the size and velocity of the wheel: allowing the Fans to have a proper inclination, the Steam Engine will also serve to clear the Ship of water with singular expedition, which is a circumstance of much importance."

This "Apparatus for working the Ship" is fixed in or beyond the stern, in or "about the place where the rudder is usually placed, and its movement is occasioned by means of an horizontal spindle or axletree, conveyed to the Engine through or above the stern end of the ship."

This was, without doubt, the best mode of steam propelling that had then been suggested; for here the steam would so act as directly to produce a circular motion on the propeller shaft. There is, however, no account of Bramah having tried this mode.

June 5, 1785. On this day a patent was granted to William Symington under the following title: "His new invented Steam Engine, on principles entirely new."

Symington published a circular, of which the following is a copy: 1785.

"Fire Engine upon a new principle and improved plan.

"Mr. Symington, the inventor of the Engine, having been equally attentive to saving of fire, and increase of power, obtained these ends by a simple construction and method of condensing the steam, so that at each stroke as perfect a vacuum is produced as the nature of steam and water will admit; and any person acquainted with the common old fire engine may easily manage and keep this one in repair. By a comparative trial made betwixt Mr. Watt's and this Engine, at Wanlock-head Lead Mines, in Scotland, in the course of last summer, it appeared,—both Engines having a cylinder 36 inches diameter, consuming the same quantity of coal, and working an equal number of strokes per minute,—Mr. Symington's wrought with a power equal to twelve pounds for each square inch contained in the area of the piston, whilst Mr. Watt's wrought with a power equal only to nine and a half pounds per square inch; that is to say, his Engine did at least one fifth more work than Mr. Watt's, upon the same consumption of fuel. Having secured his property by patent, he offers the use of his much improved Engine and its various application by a new and advantageous rotatory motion, to all those who are concerned in mines, stamps, water-works, draining of fens and lakes, grist mills, saw mills, breweries, or other manufactories which require great mechanical powers. He intends to give, make, and put it up, upon most reasonable terms.

"For particulars apply to Mr. William Symington, Engineer, Wanlock-head, by Sanquhar, North Britain.

"N.B. Steam Engines upon whatever principles, may be converted into those of the above plan at a moderate expense.

"London, Feb. 21, 1789."*

The mode adopted by Symington to obtain rotatory motion from a steam engine was by chains, ratchet wheels, and catches, as will be

* See 'Mechanic's Magazine,' vol. xix. p. 354. August, 1833.

hereafter shown; but it was inferior to the crank of Pickard, or the sun and planet wheel of Watt.

1787. In 1787, Patrick Miller published a pamphlet on the subject of propelling boats by means of paddle-wheels turned by men, and in which he gives a detailed account of several experiments which he had made with them. These wheels, much improved in form, were similar to those now generally in use. The original drawings, copies of which were attached to the pamphlet, were made by the late Alexander Nasmyth, the intimate friend of Mr. Miller; and as an important step towards the present system of Steam Navigation was thus made by the aid of Mr. Miller's pecuniary means, combined with his ardent desire to effect improvements upon the machinery previously employed for that purpose, I have been anxious to obtain authentic drawings of the kind of double sailing boat which he used at Leith. Through the kindness of Mr. James Nasmyth, Engineer, of Patricroft, near Manchester, I am enabled to furnish the accompanying engravings, accurately copied from drawings also made by the late Mr. Nasmyth, his father.

Mr. Miller's pamphlet, which fully developes the nature of his invention and the views which he entertained on the subject of Naval Architecture, has now become scarce, and is therefore here inserted.*

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* In 1825, Mr. Miller's son also published a pamphlet, in which he claims for his father the invention of Steam Navigation, and states that his father had expended in experiments the sum of nearly £30,000.

1787.

The Elevation, Section, Plan and Views, of a TRIPLE VESSEL, *and of* WHEELS, *with Explanations of the Figures in the Engraving, and a short Account of the Properties and Advantages of the Invention. By* PATRICK MILLER, ESQ., *of Dalswinton.* Edinburgh: *Printed in the year* 1787.

INVENTIONS which have a tendency to promote the happiness, or to increase the comforts of mankind in general, should, as soon as they have been brought to any degree of maturity, and can be described with tolerable precision, be communicated to the world at large.

Impressed with this sentiment, I have caused to be engraved a plan and views of a TRIPLE VESSEL, constructed on a new principle, and, also, a plan and view of a WHEEL to give her motion through the water. That engraving, with explanations, is subjoined. The PROPERTIES peculiar to vessels so constructed, with the BENEFITS which may be expected to result from them to society, I shall endeavour to describe as clearly as the nature of the subject will allow.

The years I have applied myself to this subject, and the many experiments I have made with vessels which I caused to be built for the sole purpose of improving Naval Architecture, have given rise to the INVENTION which I now communicate.

I must first remark, however, that the vessel of which the engraving gives a faithful representation, is by no means intended, in all respects, as a model, as I shall hereafter explain. I built her singly with a view to elucidate and demonstrate the truth of the principles on which my invention depends; but limited and confined by the influence of a law which prescribes the proportions that the breadths of ships must bear to their lengths.

The FIRST and principal PROPERTY of vessels constructed

1787. upon the plan here communicated is derived from the WHEELS, the mechanism of which is simple and obvious. To work them, seamanship is not requisite; for it can be performed even by the most ignorant; strength and agility, in the men employed, being all that is necessary.

From the experiments I have made in different vessels with the WHEELS wrought by cranks, as shewn in the plan, it appears to me, that ships, however great their burden, if there be no wind, and the water is smooth, may be made to pass through it at the rate of from three to four miles an hour.

When the movement of the WHEEL comes to be aided by mechanical powers, so as to accelerate its revolutions, the before-mentioned rate of a ship's going through the water will be in proportion to the power used.

I have also reason to believe that the power of the STEAM ENGINE may be applied to work the WHEELS, so as to give them a quicker motion, and consequently, to increase that of the ship. In the course of this summer, I intend to make the experiment; and the result, if favourable, shall be communicated to the public.

When there is wind sufficient to make the vessel, by means of the sails, go five miles an hour, the WHEELS are raised out of the water, as then they rather retard than aid the ship's motion.

The small DRAUGHT of WATER of vessels of this construction may be considered as the NEXT, if not their chief property.

For the purposes of inland navigation, they may be so constructed as to go where the depth of water is from 20 to 24 inches.

Vessels built to draw three feet of water will make good coasters.

Ships drawing from five to six feet of water will be very fit for the longest voyages.

STIFFNESS, a term well known to seamen, is a THIRD distinguished property of these vessels; as, of the three, the lee vessel must be immersed in the water before the ship can overset: they carry more sail than any other vessels of the same tonnage. From this

power of carrying much sail with safety, and from their displacing less water than other vessels of the same burden, there is every reason to expect that they will sail with greater velocity. 1787.

Although, from the few experiments I have yet made with the TRIPLE VESSEL, I have not been able to ascertain this matter with precision, I believe, from what I have seen, that if they are rightly constructed, and the masts and sails judiciously made, they will, in favourable situations, run fifteen or sixteen miles an hour. It is probable that, by improvements which further experience may suggest, this velocity may be increased.

A FOURTH important property of these vessels is, that of their making little or no LEE WAY, and which I am convinced of from the experiments I have made. Their HEEL, when upon a wind, being inconsiderable, the three Keels become thereby effective Lee Boards; a circumstance of great advantage when they are beating to windward.

These vessels have other PROPERTIES that deserve to be mentioned. They require no BALLAST, which must afford great room for the stowage of fewel, water, and provisions: an essential particular in long voyages, with numerous crews.

From their great BUOYANCY, they will readily rise on the sea, and therefore be less exposed to the danger of the waves breaking over them, than heavy ships which draw much water.

The BENEFITS resulting from the PROPERTIES above enumerated, and which must follow from the employing ships and other vessels constructed on these principles, are many and striking.

When there is wind, they must sail quicker than other ships; and as, during calms and light winds, they will by means of the WHEELS advance, when other ships make no progress, the duration of voyages will thus be considerably shortened. Sea risks being very much in proportion to the duration of the voyage, it is obvious many lives, and much property, will be thereby daily preserved to the world; and that, independent of the advantages which

1787. commerce must derive from the saving of time, and a speedier intercourse of nations.

Their remarkable STIFFNESS renders them the fittest vessels for rivers and canals, as every year many lives are lost by the oversetting of open boats.

Their small DRAUGHT of WATER should occasion many canals to be dug, as the expence will be inconsiderable; and the advantage of numerous canals is sufficiently known in Europe.

The same PROPERTY will have the effect of opening numberless ports, which, from their small depth of water, could never before receive vessels. Nay, where more ports are not to be found, every sand-bank may be easily made to answer the purpose; for, as a vessel of this kind will take the ground with each of its three keels at the same instant, so, if the vessel be run on the beach at high water, the crew will be able, by the return of the next high water, to dig a dock fit for her reception; and, with little trouble, she can be again set afloat upon the sea.

As these vessels sit upright on the ground, every bank is equally fit, with a dry dock, for their repairs: a matter of great importance to ships which may have received damage, or have sprung a leak near a coast deficient in ports.

It was my wish to have built the EDINBURGH on a scale sufficiently large to have rendered her fit for a voyage of any length. This would have shewn more clearly the principle of her construction, and would have enabled me to ascertain, with greater accuracy, not only the best forms and proportions of the three vessels, but also the proper distances at which they ought to be placed from each other. From an undertaking of such magnitude, however, I was not only prevented, by the attention I owed to the duties of a great business in which I was then engaged, but I was also restrained by prudence, having, during the late war, expended large sums in numberless experiments for the improvement of Artillery, with a view to

aid my country, and having, since the peace, incurred much expence in building various vessels, with a design to improve Naval Architecture. 1787.

For these reasons, I was obliged to limit myself to the building the TRIPLE VESSEL, as now represented in the Engraving; and, as I have above hinted that she is not intended, in all respects, to be a model, it will be proper here to explain myself, and to offer my opinion with respect to the figures of the vessels which may be best adapted to the different services in which they may be employed.

For inland navigation, the bottom should be flat and long, while the sides may be straight.

For the purpose of coasting, the bottom should rise a little, and the sides be somewhat round; for, although the roundness of the sides be of small importance, with a view to STIFFNESS, yet it will, in certain situations, give strength to resist the repeated beating of the sea against the sides of the vessel.

For long voyages, the bottom should be still sharper, and the sides rounder.

As to the breadth, that should be regulated by the intended tonnage of the vessel.

The depth of the vessel must be determined in part by the tonnage, and in part by the diameter of the WHEELS. These last must, in large ships, work under the lower deck beams; and, between the two beams immediately above each WHEEL, there must be a sufficient space to permit it to pass, when to be raised out of the water. When the WHEEL has only four arms, and the outer circle of iron is kept within the wooden part of them, a few inches more than the fourth part of the circumference of the WHEEL will be a sufficient space between the beams.

With regard to the dimensions of the WHEEL, it appears to me that one from seven to eight feet of diameter is as large as there can be any occasion to employ, whatever the burden of the ship may be.

1787. The number of the WHEELS should be in proportion to the length of the ship, and the number of the crew.

As to the DISTANCE which ought to be between the vessels, it is experience alone which can determine this matter with precision. In that which is represented in the Engraving, the distance between the vessels was necessarily determined by the law already alluded to, and which obliged me to direct that the breadth should bear the legal proportion to the length. I am of opinion, however, that no ships, of whatever size, will require above one or two feet greater distance between the vessels than in that on the Plan.

Having thus thrown out these few Remarks upon the INVENTION I now communicate to the world, I submit it to their consideration. As to the truth of my system, it may easily be ascertained by any Prince in Europe. It will be an undertaking patriotic and beneficent; and, if followed with the success which I expect, must be attended with the happiest consequences to his subjects.

As to myself, after some years bestowed in study and application to this subject, the present time forms to me a period of repose and satisfaction. The vessel, of which the Engraving is annexed, is the eighth which I have had built, with a view to improve Naval Architecture. One of them, built at a considerable expence, lies proscribed, and rendered useless, by the above-mentioned Statute, enacted after the vessel was launched. Notwithstanding this, I was refused a LICENCE to make experiments with her at my own expence; experiments unconnected with any sordid view, and which aimed at nothing but promoting the general welfare of mankind.

The light in which the utility of this INVENTION shall be viewed by the Public, will enable me to judge how far it may be proper to make known another SYSTEM, founded upon a combination of the Powers of an IMPROVED ARTILLERY with those of an IMPROVED NAVAL ARCHITECTURE.

That SYSTEM is of such a nature as, from its very great supe-

riority, to give a decided advantage to the state by which it shall first be adopted. My only view, however, being to promote the happiness of mankind, a discovery of this system will not be made, without having just reason to expect that it will be employed for that beneficent end. 1787

Edinburgh, February, 1787.

EXPLANATION OF THE FIGURES.

Figure 1.

A The Bowsprit.
B The Foremast.
C The Mainmast.
D The Mizenmast.
E The Cabin.
F The Tiller of the Centre Vessel.
G The Tiller of the Larboard Vessel.
H The Larboard Rudder.
III The Rails.
K Stem of the Centre Vessel.
L Stem of the Larboard Vessel.
MM The Water Line, marking the Vessel's draught of Water.

Figure 2.

AA A Section of the Cabin.
B The Larboard Wheel.
C A part of the Starboard Wheel.
DD The Grooves in which the Axes of the Wheels are raised or depressed.
EE The Water Line.

Figure 3.

A Plan of the Deck, representing it without the Cabin.

AAAA The Hatchways.
BBBBBB The stations of the Pumps.

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C The Bowsprit.

D The station of the Foremast.

E That of the Mainmast.

F That of the Mizenmast.

GG Sections of the Wheels.

HHHH The Cranks for working the Wheels.

IIII The Wells or void Spaces between the centre vessel and the two other vessels in which the wheels revolve.

N.B. By an error in the Drawing, the Wells have been made three and one half feet too long.

KKKKKKKK Open spaces in the Vessels where the men stand to work the Wheels.

LL A Circular Stage on which the helmsman stands, to steer the ship. It being raised two feet four inches above the deck, he can from thence see over the cabin, and observe objects in every direction.

M The Main Tiller.

N The Starboard Tiller.

O The Larboard Tiller.

PP The Steering Board, by which the three Tillers are connected. By its means, the centre Tiller, when moved, produces similar movements in the other two Tillers.

QQQQQQQQ The Stations of the Timber Heads and Rails.

RR The Bits to which the Cables are fastened when the ship is at anchor.

SS The Bumpkins to which the Tacks of the Foresail are extended, according to the Tack on which the ship stands.

FIGURE 4.

The Fore-part of the Ship, with the Under Arm of the Wheel at its full dip.

AA The Water Line.

FIGURE 5.

The After-part of the Ship, with the Under Arm of the Wheel at its full dip.

AA The Water Line.

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FIGURE 6.

A View of the 'Edinburgh' under sail, and the Wheels working.

FIGURE 7.

Another View of her under sail, with the Wind on the quarter, and the Wheels raised out of the Water.

FIGURE 8.

A Plan of the Wood Work of the Wheel when seen edgeways.

FIGURE 9.

A Plan of the Iron Work of the Wheels.

AAAA The Arms.
BB Circles to strengthen the Arms.

FIGURE 10.

A Perspective View of the Wheel.

Copy of a written Statement presented at a Council of the Royal Society, London, Dec. 20, 1787.

AN account of experiments made by Mr. Miller in the Firth of Forth, the 2nd of June, 1787, in a double vessel, sixty feet long and fourteen and a half feet broad, put in motion by his water wheel, wrought by a capstern of five bars, each bar five feet long. On the lower part of the capstern was fixed a wheel with teeth pointing upwards to work in a trundle fixed on the axis of the water wheel. The diameter of this wheel is equal to three and a half diameters of the trundle, so that one revolution of the capstern produces three and a half revolutions of the water wheel.

The vessel is three-masted, and sails uncommonly fast when there is a smart breeze, and the wheel is raised above the surface of the water.

After making sundry tacks in the Firth, with all the sails set, the

1787. wind fell to a gentle breeze, when all the sails were taken in, and the following experiments made.

The vessel being put in motion by the water wheel, wrought by five men at the capstern, was steered so as to keep the wind right a-head, and her rate of going was found by the log to be three and a half miles in the hour.

After this the wind was brought on the beam, (that situation being considered as the nearest to trying the effect of the wheel in a calm,) when five men at the capstern made the vessel to go at the rate of four miles an hour.

With the wind brought on the quarter, five men caused her to go at the rate of four and a half miles an hour.

Four men, at the rate of four miles an hour.

Three men, something more than three miles in the hour.

Two men, at the rate of two and a half miles in the hour.

One man, at the rate of one and three quarters of a mile in the hour.

It is proper to remark, that a vessel of the same length with that in which the experiments were made, if in real service, should be furnished with two, if not three, water wheels, and the same number of capsterns.

These experiments, and others made in a double vessel thirty-five feet long, with five wheels wrought by cranks, have enabled Mr. Miller to ascertain sundry matters of great importance, about which he entertained doubts when he wrote the Treatise.

One of these related to the power most proper to work the water wheel. He is now satisfied that the capstern possesses the power best suited to that purpose. The mechanism of the movement is simple; and by extending the bars one or two feet, the diameter of the wheel on the capstern may be enlarged, and thereby the revolutions of the water wheel will be increased, which must accelerate the motion of the ship.

He is equally satisfied as to the distance at which the different vessels should be placed from each other. He does not hesitate to say, that in a triple ship of the length and breadth of our first-rates, the vessels should not be placed at more than six feet from each other. A ship of twice the length, and about twice the breadth of our first-rates, should be quintuple; and the vessels placed at the distance of five and a half feet from each other. 1787.

From the great number of wheels which can be wrought with capsterns, in ships of these magnitudes, Mr. Miller is certain they may be made to go from four to five miles an hour in a calm; and from three to four miles an hour against light winds.

As an objection to ships of this construction, it is said that the sea will separate the different bottoms. This objection is not well founded, for top weight not being detrimental to these ships in point of stiffness, all the beams on the different decks may be of the same size; and the strength of these united must be very superior to any weight or force which can operate against it when the ship is afloat, however agitated or high the sea may be. The united strength of so many beams may be estimated in some degree by calculating the weight it will take to break an oak beam, five and a half or six feet long, of the breadth and thickness of a first-rate's lower deck beam.

PATRICK MILLER.

Dalswinton, 5th December, 1787.

Another claim to be ranked as the author or inventor of the present system of Steam Navigation was advanced by Mr. James Taylor, who is admitted to have strongly urged Mr. Miller to make a trial of his steam boat, and to have taken an active part in the experiment. Mr. Taylor may therefore be fairly said to have been instrumental in advancing the progress of the invention. In 1824 he memorialized the Chairman of a Select Committee of the House

1787. of Commons, then appointed to investigate the subject; and in his memorial, from which the following is extracted, he says,—

"Before, however, entering upon the main object, permit me to introduce it by a short statement explanatory of my connection with Mr. Miller. In the autumn of 1785, I went to live in Mr. Miller's family as preceptor to his two younger sons. I found him a gentleman of great patriotism, generosity, and philanthropy; and at the same time of a very speculative turn of mind. Before I knew him he had gone through a very long and expensive course of experiments upon artillery, of which the carronade was the result. When I came to know him he was engaged in experiments upon shipping, and had built several (ships or vessels) upon different constructions, and of various magnitudes. The double vessel seemed to fix his attention most. In the summer of 1786, I attended him repeatedly in his experiments at Leith, which I then viewed as parties of pleasure and amusement. But in the spring of 1787, a circumstance occurred which gave me a different opinion. Mr. Miller had engaged in a sailing match, with some gentlemen at Leith, against a custom-house boat (a wherry), which was reckoned a first-rate sailer. A day was appointed, and I attended Mr. Miller. His was a double vessel, sixty-feet deck, propelled by two wheels, turned by two men each. We left the harbour in the forenoon, and sailed about for some hours in the Frith; but the day falling calm, the custom-house boat could make little way. We landed on Inchcolm, where we remained for some hours waiting for a breeze to spring up. This accordingly happened in the afternoon—and a very fine breeze from the west, and fair for the harbour of Leith. The custom-house boat was managed by a Mr. Weddell, I believe still resident in Leith; Mr. Miller managed his own, manned by four men at the wheels, and we started at the same time for a fair run to the harbour. The double vessel beat by a few minutes. Being then young and stout, I took my share of the labour of the wheels, which

I found very severe exercise; but it satisfied me that a proper power only was wanting to produce much utility from the invention. I was now led to converse with Mr. Miller more frequently on the subject than formerly; and I observed to him, that unless he could apply a more commanding power than that of men, I was afraid the invention would be of little use. He answered, 'I am of the same opinion, and that power is just what I am in search of. I will explain my views. My object is to add mechanical aid to the natural force of the wind; to enable vessels to avoid or extricate themselves from dangerous situations, when they cannot do it on their present construction; and I wish also to give them powers of motion in time of calm. I am satisfied a capstan, well manned, can effect this purpose in part; but I want a power more extensively useful, which I have not as yet been able to attain. Now that you understand the subject, will you lend me the aid of your head, and see if you can suggest any plan to accomplish my purpose?' It became the daily subject of our conversation at leisure hours; we talked of many plans, but none of them satisfactory, or preferable to the capstan. At last, after beating over the whole system of mechanics, I said, 'Mr. Miller, I can suggest no power equal to the Steam Engine, or so applicable to your purpose.' He expressed some surprise, and said, 'That is a powerful agent, I allow, but will not answer my purpose; for when I wish chiefly to give aid, it cannot be used. In such cases as that disastrous event which happened lately, of the wreck of a whole Fleet upon a lee shore, off the coast of Spain, every fire on board must be extinguished, and of course such an engine could be of no use.' We continued our conversations, and very frequently reverted to the Steam Engine. In the mean time every wreck, recorded in the newspapers, called forth the most philanthropic feelings from Mr. Miller, with a strong desire to accomplish his purpose of preventing so much waste of human lives and of property. The more I thought of the business, the more I became sa- 1787.

1787. tisfied of the propriety of applying the Steam Engine; and in various conversations urged it, as at least worthy of attention for inland Navigation, rivers, canals, &c. &c. if not for the purposes of general Navigation.

"Mr. Miller said, at last, 'Mr. Taylor, you are right;—if we cannot accomplish the whole, we may a part; but will you show me how you will connect the Engine with my wheels, and I will think of it.' I made out different sketches for this purpose, which so far satisfied; and he said, 'Well, when we go to Edinburgh (we were then at Dalswinton) we will apply to an operative engineer, and take an estimate for a small Engine, and if it is not a large sum we will set about it; but as I am a stranger to the Steam Engine, you shall take charge of that part of the business, and we will try what we can make of it.'

"About this period (summer 1787) Mr. Miller wrote a narrative of his experiments upon Shipping, with a view to have it printed and circulated. He gave me the manuscript to read, and as I had witnessed a number of his experiments, requested my observations, if I saw any thing to add or correct. After perusing it I observed that he had omitted to mention the application of the Steam Engine. He said, 'I have not done that inadvertently, but from a wish not to pledge myself to the Public for a thing I may never perform: you know my intentions on that subject are yet conditional.' I said I thought not, for I was satisfied that any expense that could attach to the small scale proposed, would not prevent him from making that experiment,—that I considered the insertion of importance, and that he might throw it in prospectively, and conditionally, which would pledge him to nothing. He was persuaded, and a paragraph was inserted to that purpose. He then printed his manuscript, in folio, had it handsomely bound, and transmitted Copies to the Royal Family, to the Ministers, and many of the leading Members of both Houses of Parliament, to all the Maritime Powers in Europe, and to the President of the United States of America. We went to Town

in November, and about the new year Mr. Miller began to talk of the Estimate for the proposed Experiment, and desired me to find an operative Engineer for that purpose. 1787.

"At this time William Symington, a young man employed at the Lead Mines at Wanlockhead, had invented a new construction of the Steam Engine, by throwing off the air pump. I had seen a model work, and was pleased with it, and thought it very answerable for Mr. Miller's purpose. Symington had come into Edinburgh that winter for education. Being acquainted with him, I informed him of Mr. Miller's intentions, and mine, and asked if he could undertake to apply his Engine to Mr. Miller's vessels, and if he could I would recommend him. He answered in the affirmative, and from friendship I recommended both himself and Engine, and afterwards introduced him to Mr. Miller. After some conversation, Symington engaged to perform the work, and Mr. Miller agreed to employ him. It was finally arranged that the experiment should be performed on the Lake at Dalswinton, in the ensuing summer (1788). Accordingly in the spring, after the classes of the College broke up, I remained in Town to superintend the Castings, &c. which were done in brass, by George Watt, Founder, back of Shakspeare Square. When they were finished, I sent the articles to the country and followed myself. After some interval, I took Symington with me to Dalswinton, to put the parts together. This was accomplished about the beginning of October, and the Engine, mounted in a Frame, was placed upon the deck of a very handsome double pleasure Boat, upon the Lake. We then proceeded to action, and a more complete, successful, and beautiful experiment was never made by any man at any time, either in art or science. The Vessel moved delightfully, and notwithstanding the smallness of the Cylinders (four inches diameter), at the rate of five miles an hour. After amusing ourselves a few days, the Engine was removed, and carried into the house, where it remained as a piece of ornamental furniture for a number of years. After the experiment I made a perspective drawing of it,

1788. and its mode of connection with the Paddle Wheels, which, if the Select Committee have any desire to see, it may be forwarded for their inspection. Mr. Miller's son told me some time ago, that he had sent the Engine itself to London, with a view to have it placed in the British Museum.*

"After performing this very important experiment, I made out a note of intimation of it for the Public, and sent it to the Editor of the Dumfries Newspaper, who inserted it in his columns. It is, also, to be found in the Edinburgh Advertiser, 24th October, 1788, page 270, first column; and in the Scot's Magazine, vol. 50, page 566, November, 1788. A copy of which intimation is as follows: 'The following is the result of an experiment no less curious than new. On the 14th inst. a boat was put in motion by a Steam Engine upon Mr. Miller of Dalswinton's piece of water at that place. That Gentleman's improvements in naval affairs are well known to the Public. For some time past his attention has been turned to the application of the Steam Engine to the purposes of Navigation. He has now accomplished, and evidently shown to the world the practicability of this, by executing it upon a small scale. A Vessel 25 feet long, and 7 broad, was, on the above date, driven with two wheels by a small Engine. It answered Mr. Miller's expectations fully, and afforded great pleasure to the spectators present. The Engine used is Mr. Symington's new Patent Engine. Among the spectators of this experiment was Mr. Miller's friend, the present Sir Charles G. Stuart Monteath, of Closeburn.'

"This most satisfactory experiment produced new discussions and further resolutions. It was agreed to form a business of it, and to cover the invention with a Patent; but before incurring this last expense it was also agreed to repeat the experiment upon a larger

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* The Engine is not in the Museum, but was in London some years, and was returned to Edinburgh on the 31st of January, 1846, directed to Kenneth Mackenzie, Esq., 63, Queen Street, Edinburgh.

scale, upon the Forth and Clyde Canal, and to construct the Engine at Carron; but as the season was far advanced, this was to be the operation of the following summer. Accordingly, in spring, 1789, I repaired to Carron with Mr. Symington for this purpose, and in the course of the summer constructed a double Engine, with cylinders 18 inches diameter. 1789.

"It was the month of November before the Vessel was ready for motion. She was carried from the Carron into the Canal: we were attended by the Committee of the Managers of the Carron Company, then met upon business—Mr. Balfour of Pilrig, Mr. Adam of Blair Adam, Mr. Tibbets, Mr. Stainton, Manager, and several other Gentlemen. After passing Lock 16 we proceeded cautiously and pleasantly for some time; but after giving the Engine full play, the arms of the wheels, which had been constructed too slight, began to give way, and one float after another broke off, till we were satisfied no accuracy could be obtained in the experiment until the wheels were replaced by new ones of a stronger construction. This was done with all possible speed, and upon the 26th December we again proceeded to action. This day we moved freely without accident, and were much gratified to find our motion nearly seven miles per hour. Next day we repeated the experiment with the same success and pleasure. Satisfied now that every thing proposed was accomplished, it was unnecessary to dwell longer upon the business; for indeed, both this and the experiment of last year were as complete as any performance made by Steam Boats, even to the present day. Mr. Miller did not attend this day, and I reported to him. In his answer he directed me to dismantle the Vessel, to place the Engine within the Carron Works, to direct the Carpenter to lay up the Vessel at Bruce Haven (at that time his own property), and to call in all accounts, and bring them to the country with me. These objects accomplished, I went to Edinburgh. I there received a letter from Mr. Miller, directing me to call on Mr. Cullen, advocate, (after-

1789. wards Lord Cullen,) and to draw up with him a proper note of intimation of the experiment for the Public. Mr. Cullen appointed an evening, and after some conversation on the subject, his clerk was called in, and the following dictated to him, which I copy from the original.

"Extract of a Letter from Falkirk, February 12th, 1790.

"'It is with great pleasure that I inform you, that the experiment which some time ago was made upon the great canal here, by Mr. Miller, of Dalswinton, for ascertaining the powers of the steam engine when applied to sailing, has lately been repeated with very great success. Although these experiments have been conducted under a variety of disadvantages, as having been made with a vessel built formerly for a different purpose, yet the velocity acquired was no less than from six and a half to seven miles an hour. This sufficiently shows, that with a vessel properly constructed, a velocity of eight, nine, or even ten miles may be easily accomplished; and the advantages of so great a velocity in rivers, straits, &c. and in cases of emergency, will be sufficiently evident, as there can be few winds, tides, or currents, which can easily impede or resist it; and it will be evident that even with slower motion, the utmost advantages must result to inland navigation. It is with great satisfaction we have received this intelligence from an obliging correspondent. Every well-wisher to the extension of arts and commerce must be highly gratified with the signal success of this important experiment, which bids fair to introduce an improvement, which by greatly facilitating, and rendering more easy, the intercourse by means of navigation, must not only be highly advantageous to our own country in particular, but to the world at large, and to mankind in general.'

"The following day I made out three clean copies, and addressed them to the editors of the three newspapers then published in Edinburgh, viz. the Caledonian Mercury, Evening Courant, and Advertizer." * * * * * *

" I shall proceed to account for the interval that took place from the time of Mr. Miller's experiments, till the invention came before the public. 1789.

" Mr. Miller's pause separated him and me; and having been much pressed and solicited by a noble family, whilst these experiments were going on, to engage in some speculations of theirs, I now, with Mr. Miller's consent, entered into treaty with them; reserving the privilege of attending the Steam Boats when Mr. Miller should be inclined to move again. Two years afterwards I visited Dalswinton, to see how the agricultural improvements stood. I found Mr. Miller completely engaged, and not willing to have his attention abstracted from them; for he was quite an enthusiast in his pursuits, and this was then a very prevailing topic with gentlemen of landed property: a further delay of course followed. For several years I paid Mr. Miller occasional visits, but found him still more and more engaged in his agricultural pursuits. The cultivation of florene grass at last took such hold of him, *that no other object could withdraw him from it.* In this situation stood matters till 1801 or 1802, when Mr. Symington prevailed upon the late Lord Dundas to employ him to fit up a steam boat for the Forth and Clyde Canal Company."

This statement made by James Taylor is not in its main features denied either by Patrick Miller, jun. or by the friends of William Symington; but if further testimony were required of its general accuracy, a letter from the late Mr. Alex. Nasmyth, artist, who was present at some of the experiments with Mr. Miller's steam boat, and from whose drawings I am enabled to give the view of Dalswinton Lake, with the double pleasure boat upon it (through the kindness of Mr. Scott Russell), may be deemed sufficient. In a letter to Miss Taylor, dated 7th April, 1834, York Place, Edinburgh, Mr. Nasmyth says, " Patrick Miller, Esq., of Dalswinton, having tried many experiments with vessels of various constructions, which were built at Leith about the year 1787, trials were made of these vessels

1789. on the Firth of Forth, at which your late father, Mr. Taylor, and myself, were present, and witnessed several trials of propelling these vessels by means of paddle-wheels, turned by manual labour, &c. &c. This Mr. Miller was perfectly satisfied with. However, Mr. Taylor and I observed the men very much exhausted by the labour or turning the capstans. Sometime afterwards, having the pleasure of dining with Mr. Miller, Mr. Taylor being present, the conversation turned on the late experiments. Mr. Taylor stated as his opinion, that if a steam engine were substituted instead of the capstans, a formidable objection would be overcome, viz. the fatigue of the men,—and the vessels would be propelled with much greater velocity. Mr. Miller at first objected to this, on account of the danger of fire, &c.; but, after much consideration, he agreed to employ a person of the name of Symington, who had made a model of a steam engine, which had a rotatory motion (*then a novelty in steam machinery*), and might be applicable to Mr. Miller's vessels. Mr. Miller was much pleased with this, and proposed going to Mr. Mason's to see this model, which he did accordingly. Mr. Miller was so much pleased, that he gave orders to Mr. Taylor to introduce Mr. Symington, and accordingly employed him to make a small engine of two horse-power to be applied to a boat on Dalswinton Lake. The experiment succeeded to Mr. Miller's wish, and he often had the pleasure of sailing with parties of his friends, by the power of this small steam engine. Encouraged by this experiment, he gave Mr. Taylor orders to employ Mr. Symington to make a much more powerful engine, and to superintend the construction of it. It was put on board a vessel at Grangemouth, and sailed in that neighbourhood, and on the canal. After many successful experiments, it was laid up at Grangemouth, Mr. Miller being at the time engaged with his agricultural pursuits, at his estate in Dumfriesshire.

(Signed) "Alexander Nasmyth."

Mr. Taylor's connection with steam boat experiments ended with

those of the second boat in 1789; and it is clear, from his own state- 1789.
ments and those of his friends, that he was neither the inventor of the machinery by which either of those boats was driven, nor of the mode of connecting the engines to the boat and wheels. This, it is admitted by Mr. Taylor and his friends, was done by Symington: neither was Mr. Taylor the first person to suggest the use of the steam engine to propel boats. His merits, then, with reference to the origin and progress of steam navigation, rest entirely upon his having successfully urged Mr. Miller to try steam boat experiments, and in having devoted his time and attention in superintending the preparation of his boats for trial. Mr. Miller, it is evident, availed himself of the advice and assistance of Mr. Taylor in his several experiments; but as these experiments were made at the sole cost of the former gentleman, it must be indisputably admitted that to him we are indebted for the successful introduction of the present system of steam navigation at the early period here mentioned.

The gratitude of this country, and of all other countries deriving benefit from steam navigation, is therefore due to these two gentlemen for their important services; and it is gratifying to be enabled to state, that for Mr. Taylor's efforts to introduce steam navigation, his widow, who is still living, enjoys a pension from Government of £50 per annum, granted by the then Lord Liverpool; and that in the year 1837, each of his four daughters received a gift of £50 through Lord Melbourne. This may probably be deemed a poor reward for the services thus rendered. Mr. Miller sought no pecuniary aid, and fortunately he needed none; but after having devoted his time and talents, and nearly £30,000 of his fortune, to the improvement of artillery and the advancement of naval architecture, his services were wholly overlooked by the Government to whom he had made them known. In his pamphlet already quoted, he says, "as to myself, after some years bestowed in study and application to this subject, the present time forms to me a period of repose and satisfaction. The vessel, of which the engraving is annexed, is the

1789. eighth which I have had built, with a view to improve naval architecture. One of them, built at a considerable expense, lies proscribed and rendered useless, by the above-mentioned statute, enacted after the vessel was launched. Notwithstanding this, I was refused a *license* to make experiments with her at my own expense; experiments unconnected with any sordid view, and which aimed at nothing but promoting the general welfare of mankind."

But to return to the much disputed point, the invention of the *first practical steam boat.* It has been already shown that Mr. Taylor's efforts at steam propulsion ended in 1789; and had he been the inventor of the engines used in Mr. Miller's two double boats, and the only person who had applied those engines to boats and wheels, he could not be fairly considered as the inventor of the present system of steam navigation. The engines were certainly an improvement upon those of Papin and Hull, but they were incapable of being beneficially used in practical navigation; and such they must have

1796. May 3. appeared to Mr. Miller himself, for on the 3d of May, 1796, that gentleman obtained a patent for "his new invented method of a new construction, which draws less water than any other vessel of the same dimensions, which cannot founder at sea, and which is put in motion in calms and in light winds, by a method never before practised." This fact must have been forgotten or overlooked by Mr. Taylor and Mr. Miller's son, as he is said to have "turned his attention to agricultural improvements on his own estate, and that in this situation matters stood till 1801 or 1802."

The specification of this patent, as it is not of great length, is here given. "I, the said Patrick Miller, do hereby declare, that my said invention and discovery is described in manner following: that is to say, the said vessel is kept afloat without the aid of its sides, solely by the aid of its bottom, which is flat, the bottom never being so deeply immersed as to bring the upper surface thereof on a level with the water; such vessel not being constructed for the purpose of carrying cargoes, but for that of carrying passengers, with the necessary

stores and provisions; and as these vessels are not kept afloat by the aid of their sides, but by the buoyancy of their bottom, as above described, they cannot sink, and therefore pumps are not required, nor are they in any respect necessary for the preservation of such vessels. The said vessel is put in motion, during calms, and in light winds, by means of wheels. These wheels project beyond the sides of the vessels, and are wrought by means of capstans: the number and the dimensions of the wheels depend upon the length of the vessel. These wheels are built with eight arms, which consist entirely of plank. Sliders are used to work and to keep the vessel to windward when under sail. These sliders are placed in the centre of the vessel, from stem to stern; they are made of plank, and the number and dimensions must depend on the length of the vessel; and they are raised and let down, either by the hand or by means of a purchase, according to the size of the vessel. 1796.

"Vessels of this construction draw water in proportion to their dimensions, as follows: a vessel of forty feet in length, and from thirteen to nineteen feet in breadth, will draw from thirteen to sixteen inches of water. One of fifty feet in length, and from seventeen to twenty-four feet in breadth, will draw from sixteen to eighteen inches of water. One sixty feet long, and from twenty to twenty-eight feet broad, will draw from eighteen to twenty-one inches of water. One seventy feet long, and from twenty-three to thirty-two feet broad, will draw from twenty-one to twenty-four inches of water. One eighty feet long, and from twenty-seven to thirty-seven feet broad, will draw from twenty-four to twenty-seven inches of water. One ninety feet long, and from thirty to forty-two feet broad, will draw from twenty-seven to thirty inches of water. One of one hundred feet in length, and from thirty-three to forty-seven feet in breadth, will draw from thirty to thirty-three inches of water.

"As, from the principle upon which this vessel is constructed, she cannot sink, the invention must prove a means of saving many lives; and as it will give more room and height between the decks than

1796. any vessel of the same dimensions, of another construction, it must add greatly to the comfort and accommodation of persons at sea, of all descriptions.

"It is expected that, from these advantages, a more general and friendly intercourse amongst nations will take place, which will have the effect to diffuse knowledge and to remove national prejudices, thereby promoting the general welfare of mankind. At present it would be altogether improper to give any description of ships of greater dimensions, lest it should be converted to a purpose very different from that intended by the inventor.

(Signed) "PATRICK MILLER."

This patent, obtained by Mr. Miller seven years after the last of his steam boat experiments, already noticed, naturally leads to the opinion that he had no faith in the results of his steam trials with Mr. Taylor and Mr. Symington, as he might have added to this invention, in the same patent, that of his former steam boats, without incurring any additional expense; and the more unhesitatingly will that opinion be arrived at when it is known that he had entered into some kind of arrangement with Mr. Taylor, Mr. Symington, and others, whereby he was to be a participator with them in profits, as will be hereafter shown. Should this conclusion be deemed erroneous, Mr. Miller has himself placed the matter beyond all doubt; for in a letter written by him to Mr. Taylor from Dalswinton, on the
1789. 7th December, 1789, he says,

"Dear Sir, I got home last night. You may easily imagine that my thoughts have been a good deal taken up, since I saw you, with what passed at Carron on Wednesday and Thursday.

"I am now satisfied that Mr. Symington's steam engine is the most improper of all steam engines for giving motion to a vessel, and that he does not know how to calculate frictions or mechanical powers.

"By means of a new well constructed water-wheel, and the

pinion being doubled in diameter, I doubt not that the velocity of 1796.
the vessel's motion through the water will be increased; but, do as you will, a great deal of power of the engine must be lost in friction. I remember well that when the small engine was wrought in the boat at Dalswinton, I had formed the same idea, and that I told you so; but not having studied the subject, I gave up my own common sense.

"This is now past remedy. As the engine cannot be of use to me now, I hope, with the aid of Mr. Tibbets and Mr. Stainton, you will get it sold before you leave Carron. I expect to hear from you soon how matters go on. Remember the iron bolts or rabbits that drew on two different trials; they will do so again if they are not made stronger. It was folly in the extreme not to have perceived at the first that their strength was not in proportion to the other parts of the engine, &c.

(Signed) "P. Miller."

Thus we have Mr. Miller's opinion that Symington's engine was "the most improper of all steam engines for giving motion to a vessel," after his experience of both the small and the larger one; and in "giving up his own common sense," as he observes, he did wrong, for there can be no doubt that such an engine was useless for the purpose of practical steam navigation. That the experiments were performed, as stated, no one, after the respectable testimony given, can disbelieve.

"In the year 1788, John Fitch applied for and obtained a patent 1788.
for the application of steam to navigation in the States of Pennsylvania, New York, New Jersey, Delaware, &c.; and soon after Mr. James Rumsey, conceiving that he had made some discoveries in perfecting the same, applied to the state of Pennsylvania for a patent.

"But a company formed by John Fitch under his state patents, of which the author of this (Dr. Thornton) was one of the principal shareholders, conceiving that the patent of Fitch was not for any

1783. peculiar mode of applying the steam to navigation, opposed the application of Rumsey and his party, and the decision of the legislature being in favour of Fitch, Rumsey's company were excluded from 'the right of using steam boats on any principle.'" Dr. Thornton goes on to say, 'we worked incessantly at the boat to bring it to perfection, and some account of our labours may be seen in the Travels of Brissot de Warville in this country; and under the disadvantages of never having seen a steam engine on the principles contemplated, of not having a single engineer in our company or pay, (we made engineers of common blacksmiths,) and after expending many thousand dollars, the boat did not exceed three miles an hour.'

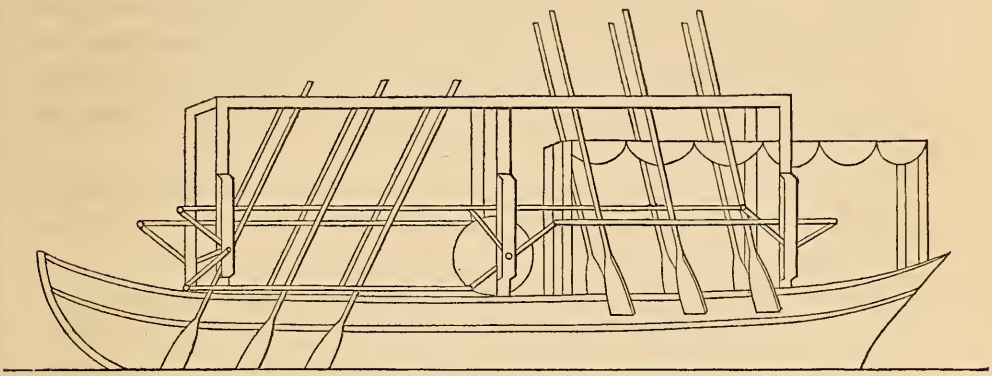
"Many of the shareholders in Fitch's company were unwilling to proceed, but Dr. Thornton and a few others undertook to make her go at the rate of eight miles an hour within eighteen months, or forfeit all the expenditure on failing. These terms being agreed
1789. to, a second experiment was made. Dr. Thornton says, 'I was among the number who proceeded, and in less than twelve months we were ready for the experiment; a mile was measured in Front-street (or Water-street) Philadelphia; every precaution was taken before witnesses, the time was shown to all, the experiment declared to be fairly made, and the boat was found to go at the rate of eight miles an hour, or one mile within the eighth of an hour.'

"It afterwards went eighty miles in one day. Governor Mifflin, attended by the Council of Pennsylvania, came in procession, and placed in the boat a superb silk flag, prepared expressly for the purpose, and containing the arms of Pennsylvania.

"Fitch went to France by invitation of the Government, to construct some steam boats for them, and took his flag with him, and presented it to the National Convention: not finding engineers, however, who could execute his plans, and other circumstances arising, he returned to America at the cost of Mr. Vael, the Consul at L'Orient."

The same document states that "the conviction of Fitch, however, respecting the power of steam, continued firm;" and that in June, 1792, the boat was laid up.* 1789.

In Brewster's Encyclopædia is contained the following extract from the "Columbian (Philadelphia) Magazine," vol. i. Dec. 1786, in which Fitch describes to the public the plan on which his projected steam boat was to be built. "The cylinder is to be horizon-



tal, and the steam to work with equal force at each end. The mode by which we obtain what I call a vacuum, is, it is believed, entirely new, as is also the method of letting the water into it, and throwing it off against the atmosphere without friction.

"It is expected that the cylinder, which is of twelve inches diameter, will move a clear force of 11 or 12 hundred weight after the frictions are deducted: this force is to be directed against a wheel of eighteen inches diameter. The piston is to move about three feet, and each vibration of it gives the axis about 40 evolutions. Each evolution of the axis moves twelve oars or paddles five and a half feet: they work perpendicularly, and are represented by the strokes of a paddle of a canoe. As six of the paddles are raised from the

* "A short Account of Steam Boats, by Dr. Thornton, Director of the Patent Office, Washington, United States."—*Monthly Magazine*, October, 1815.

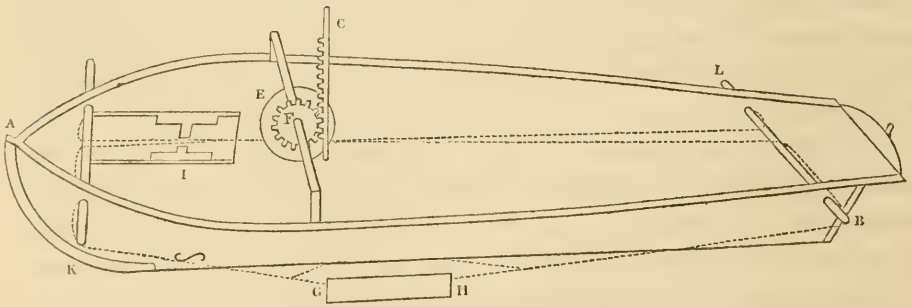
1789. water six more are entered, and the two sets of paddles make their strokes of about eleven feet in each evolution. The crank of the axis acts upon the paddles about one-third of their length from their lower ends, on which part of the oar the whole force of the axis is applied. The engine is placed in the bottom of the boat about one-third from the stern, and both the action and reaction turn the wheel the same way. Fitch gives a particular account of the progress of his operations in steam from the first time that the thought occurred to him of using it to the completion of the boat, so far as to make numerous experiments on the Delaware of the subsequent alterations made in the engine, and of the final abandonment of the scheme by the original subscribers."

Reduced by this his favourite project to poverty and distress, he terminated his life by plunging into the Alleghany.

1788. Nov. 6. James Rumsey, an American, who has been already mentioned in the account of Fitch's experiments, and who was refused a patent in America, came over to England, and obtained one here in 1788, the title of which is "For his invented methods of constructing Boilers for Distillation and other objects, and for Steam Engines for various purposes."

That part of his Specification which relates to propelling is as follows:—

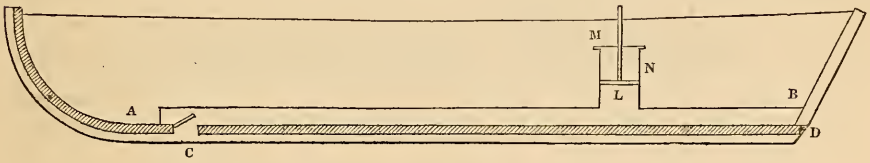
"Fig. 18 represents a boat and machinery to which I give motion



James Rumsey's Steam Boat, 6th Nov. 1788.

by applying one of my boilers and its connections to move the piece C up and down forcibly. The wheels E and F are turned backward and forward. By this operation the ropes or chains seen in dotted lines, from their connection with the wheel E, move backward and forward the box G H, in which is a valve at G; and the carriage I, which moves in grooves, draws forward the box with little resistance by the valve at G opening; but when it is drawn towards the stern of the boat, the water enclosed within it by the shutting of the valve, prevents the box from moving back by its weight, whilst the boat is drawn forward by the ropes connected with the wheel E: these ropes move round sheaves in the pieces of timber K L. The carriage (I) has poles connected with it which hang on swivels, and act upon the bottom in shallow water. 1788.

"Fig. 19, the section of a boat with A B, a trunk, in its bottom,



James Rumsey's Steam Boat, 6th Nov. 1788.

which has a valve C communicating with the water that floats her. M and N is a cylinder screwed on the trunk A B, and has its piston L connected with the bolt I, to which I apply one of my boilers, by which means water is drawn through the valve C and trunk A B, and is discharged through the valve D, which causes the boat to move forward."

In 1790, James Rumsey obtained another English patent for propelling vessels, the title of which is for "his new invented methods of applying Power of Water, of Air, and of Steam, either separately or together, as circumstances may require, to the purposes of milling, and giving useful motions or effects to various kinds of Machines, and for the advantageous management of Shipping and 1790. March 24.

1790. Vessels of all descriptions used in or upon the water, of all kinds, in various circumstances and situations." In regard to propelling, the Specification states the invention to consist—"First, in giving powerful

Fig. 1.

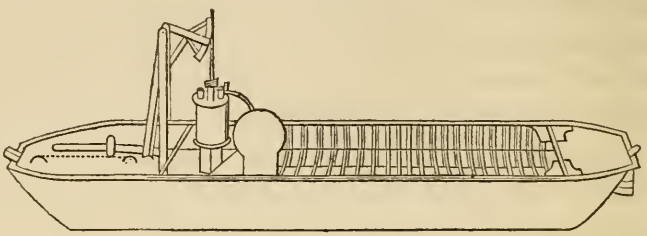


Fig. 2.

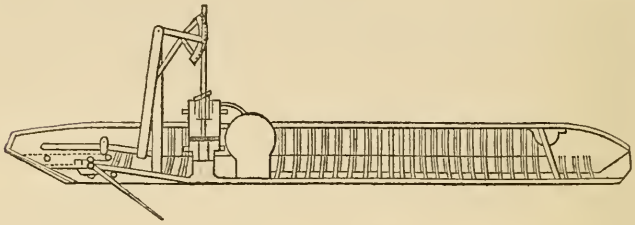
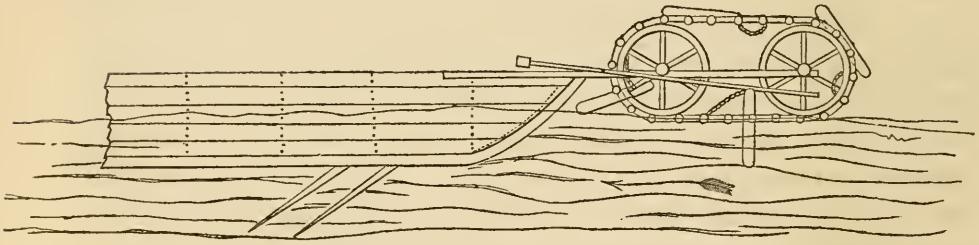


Fig. 3.



James Rumsey's Steam Boats, 24th March, 1790.

motion to vessels, machines, and engines, by means of the reaction occasioned by projecting, discharging, or forcing of water or other matter from them by the power of steam or other agents applied so as to exert their force between the vessel or machine to be moved, and a column of water or some other body that is independent of such

vessel or machine (as powder exerts itself between a cannon and the independent ball). 1790.

"Second, in giving motion to vessels, &c. by the force of steam or other power, &c. Third, in giving powerful motion to vessels, &c. by causing water, steam, or air to act separately or together against either water, pistons in cylinders, tubes, or cranks, or against wheels connected with moveable boxes, tubes, trunks, cranks, carriage wheels, weights, springs, or poles, or against one or more of them, so as to produce motion. Fourth, in making useful the mill, or revolving tube of Barker, for the aforesaid purposes, I apply my inverted steam forcing engine to move vessels at sea in deep water, by connecting it with (and forcing water through) trunks, or tubes fixed within or layed parallel with the keel of the vessel to be moved, or with those that are formed by building a vessel with two or more keels. I also construct a large vessel in which to float others in shallow water."

Rumsey succeeded in inducing a wealthy American merchant, then residing in London, and some equally sanguine natives, to disburse the expenses of an experiment. He had spent nearly two years in preparations, and was on the eve of putting the last hand to his steam boat when he died. The parties, however, who were associated with him in the enterprize got the vessel afloat in February, 1793, and sailed her many times on the Thames, against wind and tide, with the speed of four knots an hour. The propelling machinery was similar to that shown in the drawing of his patent of Nov. 6, 1788, marked fig. 19, consisting of a pump which was two feet in diameter, wrought by a steam engine which forced a quantity of water through the keel; the valve was then shut by the return of the stroke, which at the same time forced the water through a channel or pipe, about six inches square, out at the stern, under the rudder, which had a less depth than usual, to permit the exit of the water.* 1793.

* Stuart, vol. ii. p. 411; "Engineers' and Mechanics' Encyclopædia," vol. ii. p. 745.

1793. Rumsey, as well as Fitch, had long conceived the notion of propelling vessels by steam power before they put their projects to an experimental test; for in the year 1784, James Rumsey mentioned to General Washington the project of Steam Navigation, and soon afterwards Fitch showed the General a model of his proposed boat; he also presented a model (perhaps the same) and description of his apparatus to a Philosophical Society in Philadelphia, 1785.

In the order of date, a second series of experiments on Steam Navigation is arrived at, conducted solely by William Symington, engineer, who has been previously mentioned in connection with Mr. Miller, of Dalswinton, and Mr. James Taylor, and the steam boat experiments carried on by the three in the years 1788 and 1789, in which Symington's patented engine of 1785 was used.

Before entering into the description and merits of these latter experiments, I here extract a portion of a letter addressed by Mr. John Taylor (brother to Mr. James Taylor) to the Countess of Dumfries, to show that an agreement did exist between Mr. Miller, Mr. Taylor, and Mr. Symington and others, in regard to the participation of profits, if any, that might arise from Steam Navigation as experimented upon by them in 1788. And I do this in order that it may clear up a charge subsequently made against Mr. Symington's honour and ingenuity; and in order, also, to show that it has been used to establish a claim to the invention of Steam Navigation for James Taylor. The extract is as follows:—"He (Mr. James Taylor) proposed to Mr. Miller the applying our steam engine to his boat, which William Symington and he did with success upon a small scale; and at present an engine for a boat of thirty tons burden is founding at Carron, to show the world the utility of the scheme. My brother has a small share in our engine business, which we hope will turn to account in time; and in consequence of our agreement with Mr. Miller, we are to have one-half of the profits arising from his boat scheme, if any there be; and as Mr. Miller's whole dependence is on my brother for managing and

executing the scheme, he proposes to give him a certain share, distinct from his share with the Symingtons and me." 1793.

I shall, also, before proceeding further, endeavour to arrive at Mr. Symington's views of the experiments tried in 1788, which were similar to those tried in 1789, except as regards scale.

As he appears to have had a direct pecuniary interest with Mr. Miller and Mr. Taylor and others in Steam Navigation, and as the experiment of 1788 was stated to be "as complete, successful, and beautiful as any ever made by any man, at any time, either in art or science," how does it happen that in Symington's circular of 1789 he does not say that his engine would be useful to propel boats, although he mentions its utility, where circular motion is required, to almost all other purposes; and although at that very time he was engaged with the second double boat of thirty tons burden? He must either have entertained the same opinion as Mr. Miller as to its inefficiency for practical propelling, or have been deterred from using it by the terms of his agreement, except in conjunction with the other parties in the Steam Boat contract.

In the year 1801, the late Thomas, Lord Dundas, of Kerse, who was acquainted with the experiments that had been made by Mr. Miller, and who was an extensive proprietor of property in the Forth and Clyde Canal, employed Mr. Symington to make a series of experiments on Steam Boats, to enable them to be substituted for the horses then employed to draw the vessels on the canal. These experiments occupied a period of time from January, 1801, to April, 1803, and the cost of them is stated to have amounted to a sum exceeding £7000.

The result of these experiments was the production of the "First Practical Steam Boat," named the *Charlotte Dundas* in honour of his Lordship's daughter, the late lamented Lady Milton.

This vessel might, from the simplicity of its machinery, have been at work to this day with such ordinary repairs as are now occasionally required to all steam boats.

1793. In this vessel there was an engine with the steam acting on each side of the piston (Watt's patented invention), working a connecting rod and crank (Pickard's patented invention), and the union of the crank to the axis of Miller's improved paddle-wheel (Symington's patented invention). Thus had Symington the undoubted merit of having combined together for the first time, those improvements which constitute the *present system of Steam Navigation.*

In the month of March, 1802, Mr. Symington took on board this Vessel, at Loch No. 20 of the Canal, Lord Dundas, the Honourable George Dundas, R. N., Archibald Spiers, Esq., of Elderstee, and several other Gentlemen; and after having attached to the steam boat two other boats, each of seventy tons burden, named the *Active* and *Euphemia*, it towed those vessels to Port Dundas, Glasgow—a distance of nineteen miles and a half—in six hours, (being at the rate of three miles and a quarter per hour,) although it blew so strong a gale right a-head, during the whole day, that no other vessel on the Canal attempted to move to windward.

Proofs having been given of the efficiency of this Vessel to supersede horses for towing, proposals were made to the proprietors of the Forth and Clyde Canal to adopt it; but from an opinion that the waves it created would damage the banks, and thereby cause injury to a greater extent than any benefit that might accrue, the proposal was rejected. Lord Dundas, however, entertained a more favourable opinion on the subject, and called upon the Duke of Bridgewater for the purpose of recommending the adoption of Symington's steam boat. His Grace at first appeared to doubt the utility of the invention, but after having seen a model, and received explanations from Mr. Symington, he gave him an order to build eight boats, similar to the *Charlotte Dundas*, to ply on his Canal.

Mr. Symington returned to Scotland elated with the prospect of being able to introduce Steam Navigation in a short time, and to realize to himself the advantages which his ingenuity and unwearied perseverance gave him reason to anticipate; but he was doomed to

disappointment; for on the same day that he was informed by Lord Dundas of the final determination of the Committee not to allow steam boats to be employed on the Canal, he received intelligence of the death of the Duke of Bridgewater. 1793.

Unable longer to struggle against his misfortunes, his resources being exhausted, he was obliged, with great reluctance, to lay up his boat in a creek of the canal, near to Brainsford draw-bridge, where it remained for a number of years exposed to public view.

From the experience that Symington had obtained in his experiments with Mr. Miller's boats, and from the circumstance of the double-acting Cylinder and Crank being at the time of his engagement by Lord Dundas used in Stationary Engines, he abandoned his own old engine, and obtained a Patent for applying a Double-Acting Reciprocating Engine to a Boat, and for placing his crank upon the axis of the paddle-wheel, which was a good subject-matter for a patent, and a very important discovery and improvement. From the establishment of this combination of machinery to a Boat, no improvement on this system has even to the present time been effected, either in this or in any other country; and this the *parent Boat* of the present system of Paddle-Wheel Steamers is represented from a drawing by the late Mr. Symington himself. The second Patent, to which I have already alluded, was obtained in the year 1801, and the title of it is—"A new mode of constructing Steam Engines, and applying their power to the purposes of producing Rotatory and other motions without the interposition of a Lever or Beam." 1801. Oct. 14.

The descriptive part of the Specification begins as follows: "The Drawing annexed shows my new method of constructing Steam Engines and applying their power for the purpose of producing Rotatory Motion without the intervention of a Lever or Beam, viz.:—The Steam Cylinder A is placed in a horizontal position, and the piston-rod B coupled to one end of the crank arm C, and the other end of the arm attached to the Crank (the piston-rod being kept parallel to the axis of the Steam Cylinder by slides or rollers as represented in the draw-

1801. ing): a motion backward and forward being produced in the piston of the Steam Cylinder, the Crank will be turned round, and a rotatory motion produced in the first spindle or lying shaft. The power of the Engine may be thus applied in producing rotatory motion by the revolving wheel, in place of the crank. When a reciprocating motion is wanted, the piston-rod of the steam engine must be coupled to a pump rod, piston rod, or other body, wished to be so moved; and the engine being set to work, a reciprocating motion will be thus produced. Although the steam cylinder is represented in the drawing in a horizontal position, it may be applied to produce the above motions when placed in a perpendicular position, or any of the different angles between a perpendicular and horizontal position, as circumstances may require.

"The above-mentioned construction of steam engines is peculiarly adapted for navigating boats, vessels, or rafts in canals or rivers, and for breaking the ice on them, and may be used in manner following. First, a wheel or wheels with blades may be placed in a boat, vessel, or raft, to act in such manner upon the water when put in motion by the steam-engine as to be able to impel the boat, vessel, or raft, which may be used instead of horses to drag boats, vessels, or rafts, and a wheel or wheels may be placed to act within the boat, vessel, or raft, if constructed with two keels, or divided from stem to stern, *or upon the outside of those built in common form*, as circumstances may require. *The principle of this invention comprehends any species of machinery thus put in rotatory motion by a steam engine, which may be made use of to navigate boats, vessels, or rafts.* Second, to break ice, a number of beaters, hammers, or stampers may be placed in the bow quarter of the boat, vessel, or raft, which beaters, hammers, or stampers, when put in motion by the steam-engine, may revolve upon an axis, or be worked by an up and down motion in manner of common tilts or stampers.

(Signed) "William Symington."

About the year 1825 Mr. Symington was induced to present a memorial to the Lords of his Majesty's Treasury, in consequence of which the sum of £100 was awarded from his Majesty's privy purse, and a year or two afterwards a further sum of £50. He had cherished the hope that an annual allowance might be procured, but he was disappointed. He also received a small sum from the London steam boat proprietors, through the influence of Mr. James Walker. 1801.

In the decline of life he appears to have had several kind relatives and friends who contributed to his support; and among the number was Lord Dundas.

Before dismissing Symington's claim as the inventor of "the present system of steam navigation," I here give a copy of a letter written by him to Mr. Taylor, which has been used for the purpose of proving that Symington had furtively taken his second patent in his own name, and that the letter bears indirect proof of Mr. Taylor having been the inventor.

"Sir, Glasgow, 9th Feb. 1821.

"In terms of our former agreement, when making experiments of sailing by the steam engine, I hereby bind and oblige myself to convey to you by a regular assignation, the one-half of the interests and proceeds of the patent taken by me upon that invention, when an opportunity occurs of executing the deed, and when required.

"I am, Sir,

"Your obedient Servant,

(Signed) "William Symington."

The offer thus made to Mr. Taylor has distinct reference to some "former agreement;" and it is not unusual, but general, in contracts with patentees, that they are bound to transfer to the parties to the first agreement an interest in any subsequent discovery or invention on the same subject.

Such appears to be the case in this instance; if it were not so,

1801. and if the second invention did not originate with Mr. Taylor (of which his friends have given no shadow of a proof), Mr. Symington was not performing an act of justice to himself in making the transfer of the half of his patent.

Should the invention of the combination of machinery in the *Charlotte Dundas* be again attributed to any other person than William Symington, which in all probability may be the case, the advocates of such other claimant, *by bringing forward proofs of prior invention and application*, will set the matter at rest so far as Symington is concerned, and make a ready convert of the author of this work.

1804. John Cox Stevens, an American mechanician, in the year 1804 made an experiment to propel a boat by a rotary engine, on the axis of which revolved a wheel at the stern of the boat, like a windmill or smoke-jack, but he found it impossible to preserve a sufficient degree of tightness in the packing of the engine; and a second modification of his rotary apparatus, on trial, proving no better than the first, he had recourse to Watt's engine, with a cylinder four and a half inches diameter, and a nine-inch stroke: the beam was omitted; the boiler, two feet long, fifteen inches wide, twelve inches high, consisted of eighty-one copper tubes, each an inch in diameter; his boat was twenty-five feet long and five feet wide. This boat was tried in May, 1804, and attained a velocity of four miles an hour. After having made repeated trials with her, his son undertook to cross from Hoboken to New York, when unfortunately, as the boat nearly reached the wharf, the steam pipe gave way, having been put on with soft solder. The boiler being damaged, he next constructed one with the tubes placed vertically. The engine was kept going for a fortnight or three weeks, the boat making excursions of two or three miles up and down the river: for a short distance he could make it sail at a rate of not less than seven or eight miles an hour.*

Mr. Stevens, jun. has the merit of being the first person who took

* Stuart, vol. ii. p. 467.

a steam boat to sea; and it is highly probable that this boat was propelled by a screw, constructed on the principle of a windmill or smoke-jack. 1804.

Stevens commenced his experiments on Steam Navigation in 1791, and they were continued for sixteen years. During a part of this time he was assisted by Livingstone (who will be mentioned hereafter). Stevens has declared that he spent twenty thousand dollars, in addition to so many years of his life, on this project, without deriving any benefit. He obtained a patent in England, on the 31st of May, 1805, the title of which is as follows:—"A grant unto John Cox Stevens, of New York, North America, but now residing in New Bond Street, Middlesex, Gentleman, for his new method of generating steam."* It appears from this patent that he did not consider he had discovered a practical mode of propelling vessels, but that his tubular boiler was the only part of his invention worth securing. 1805. May 31.

About this period, Oliver Evans, an ingenious mechanic and a townsman of Fitch, was endeavouring to mature a plan for using steam of a very high pressure, chiefly with a view of propelling waggons on the common roads (for which at this period he obtained a patent in Maryland); and he states that he published in 1785, a description of a mode of propelling vessels by steam. From this circumstance he has been regarded by some authors as the contriver of "practicable" steam boats; but his narrative contains no propositions with regard to steam boats that had not been previously suggested; and the only facts adduced of his practice are thus related by himself.

"In the year 1804, I constructed at my works, situated a mile and a half from the water, by an order of the Board of Health of the city of Philadelphia, a machine for cleansing docks. It consisted of a large flat or lighter (a flat-bottomed boat thirty feet long and twelve

* The specification of this patent is published in the "Repertory of Arts," vol. vii. second series, p. 173.

1805. feet broad), with a steam engine of the power of five horses on board, to work machinery to raise mud (with a chain of buckets) into lighters.

"This was a fine opportunity to show the public that my engine could propel both land and water carriages, and I resolved to do it. When the work was finished, I put wheels under it, and though it was equal in weight to two hundred barrels of flour, and the wheels were fixed on wooden axletrees for this temporary purpose, in a very rough manner, and attended with great friction of course, yet with this small engine I transported my great burden to the Schuylkill with ease; and when it was launched into the water, I fixed a paddle-wheel at the stern, and drove it down the Schuylkill to Delaware, and up the Delaware to the city; leaving all the vessels going up behind me, at least half way, the wind being a-head."

1806. In the year 1806, Robert Fulton, an American engineer, in conjunction with Chancellor Livingstone, commenced to build a steam boat in America, in the building yard of Charles Brown, on the east (Hudson) river: she was launched in the spring of 1807, and her 1807. machinery was completed in August, 1807; after which a trip was made with her, in which she attained a speed of nearly five miles an hour. Fulton, perceiving that her paddles entered too deeply into the water, had them removed and placed nearer to the centres of the wheels.

An announcement soon afterwards appeared in the newspapers of the day, that the steam boat built by Messrs. Livingstone and Fulton would depart in the afternoon of a day fixed, from New York to Albany. Mr. Fulton went this voyage, and upon his return published an account of it as follows:—

"*To the Editor of the American Citizen.*

"SIR,

"I ARRIVED this afternoon at four o'clock in the steam boat from Albany. As the success of my experiment gives me great hopes

that such boats may be rendered of great importance to my country, 1807.
to prevent erroneous opinions, and give some satisfaction to the friends of useful improvements, you will have the goodness to publish the following statement of facts.

"I left New York on Monday at one o'clock, and arrived at Clermont, the seat of Chancellor Livingstone, at one o'clock on Tuesday; time twenty-four hours, distance one hundred and ten miles. On Wednesday I left the Chancellor's at nine in the morning, and arrived at Albany at five in the afternoon; distance forty miles, time eight hours, equal to nearly five miles an hour, &c.

(Signed) "Robert Fulton."

This vessel was named the *Clermont*, after the residence of Chancellor Livingstone. Her dimensions were,—length 130 feet, breadth 16½ feet, depth 7 feet; the boiler was 20 feet long, 7 feet deep, and 8 feet broad. The steam cylinder was 24 inches in diameter, and the piston made a stroke of 4 feet. Her burden was 160 tons. The axle of her paddle-wheel was cast iron, but it had no outer support. The diameter of the paddle-wheels was 15 feet, the paddles 4 feet long, dipping into the water 2 feet.

She ran, during the remainder of the year, as a passenger boat between New York and Albany, a distance ascertained by a late survey to be 125 geographical miles. To provide more extended accommodation for passengers, she was in the ensuing winter lengthened to the extent of 140 feet keel.

In the beginning of the year 1808, the *Clermont* was placed for regular work, to ply between New York and Albany, and she was crowded with passengers. According to Colden, the biographer of Fulton, her speed was, after the alteration, at the rate of five miles an hour: he states her speed to have been previously at nearly five miles an hour.

This celebrated steam vessel was the first that commenced and

1807. continued to run for practical purposes, and for the remuneration of her owners.

Fulton's difficulties were not over after the vessel was in operation: she was often intentionally run foul of, to produce damage; and to such an extent did this spirit of hostility manifest itself, that the Legislature passed a law to punish, by fine and imprisonment, any person who attempted to destroy or injure her.

For the annexed sketch of this vessel, and her machinery, I am indebted to Joseph C. Dyer, Esq. of Burnage, near Manchester, who was personally acquainted with the late Mr. Fulton, and who has travelled in the *Clermont*.

Messrs. Livingstone and Fulton obtained from the Legislature of New York the exclusive privilege of navigating that State by steam vessels, for a period of twenty years; and when the Legislature were convinced of the great utility of the invention, they extended the term five years for all steam boats on this peculiar plan. This monopoly, however, they were not long permitted to enjoy, for (says Colden, page 236) "During the whole time that Fulton had been devoting his talents to the service of his country, he had been harassed by law-suits and controversies with those who had been violating his patent rights, or intruding upon his exclusive grants;" and at page 238,—"Mr. Daniel Dod and Mr. John Fitch oppose Messrs. Livingstone and Fulton, and petition to have the grant rescinded which they then had to exclusively navigate certain waters. A Committee of the House of Assembly made a report on this case; and, among others, the following statement: 'That the boats built by Livingstone and Fulton were in substance the invention of Fitch:'" a most unjust decision, Fitch's mode being valueless, and Fulton's practicable.

Born 1765. Mr. Fulton died on the 24th of February, 1815, having lived to see steam navigation generally introduced in America and Great Britain; and although his countrymen are justly proud of his merits now that he is dead, they suffered him, (says Colden,) to die and leave his family in embarrassed circumstances.

It may by some be supposed, from what has already been said of Fulton, that he had made some great improvements in the machinery of steam boats, or in the boat itself; and some American authors go so far as to say that he was the inventor of Steam Navigation. 1807.

Fulton is entitled to the undoubted and great merit of having introduced steam for practical purposes; but he was not the inventor of the system which he thus introduced.

Colden says, "he conceived the idea of propelling vessels by steam —as early as 1793;" and in some of his manuscripts he speaks with great confidence of its practicability.

In 1796, however, he published in London a Treatise on Canal Navigation, in which he makes no mention of steam boats.

In 1801, Mr. Fulton was in Paris, and thus had an opportunity of conversing with Chancellor Livingstone, at that time the representative of the United States at the Court of France, on the subject of steam navigation.

"Mr. Fulton, (says Colden,) in conjunction with Robert Livingstone, Esquire," (who had formerly been associated with Stevens in America in making experiments on steam navigation,) "built an operating boat upon the Seine, for which an engine was ordered in England. This experimental boat, which was 66 feet long and 8 feet wide, was completed in 1803. When on the point of making the first experiment, the weight of the machinery broke the boat into two parts, and they went down together. The repairs were completed in July. On trial, however, the boat did not move with as much speed as Mr. Fulton expected."*

The combination of the machinery applied to this boat is not specified; but assuming it to have been similar to that subsequently adopted for the *Clermont* in 1807, it may be compared with the inventions specified by Symington in his patent of 1801; namely, a

* Pages 150, 152, 164.

1807. cylinder with steam acting on each side of the piston, with an air pump and detached condenser (Watt's invention); connecting rods and cranks to obtain rotary motion, and a fly wheel to get over the dead points of the engine (Pickard's invention); improved paddle-wheels (Miller's invention); and the combination of these instruments together for the first time in a boat (Symington's invention). *In fact, if these inventions separately, or as a combination, were removed out of Fulton's boat, nothing would be left but the hull; and if the hull could then be divested of that peculiarity of form, admitted to have been derived from Colonel Beaufoy's experiments, all that would remain would be the hull of a boat of ordinary construction.*

The Americans admit that they are indebted to Fulton for the art of steam navigation, and it will be proved that he obtained that art entirely from the inventions of British subjects.

Mr. Fulton having heard of the successful experiments of Symington, was naturally led, by his desire to accomplish the same end, to pay Symington a visit, the result of which is thus circumstantially related. "It happened one day during the month of July, 1801, while Mr. Symington was conducting his experiments under the patronage of Lord Dundas, a stranger came to the banks of the canal, and requested an interview: he announced himself as Mr. Fulton, a native of North America, to which country he intended to return in a few weeks; but having heard of the steam boat experiments, he could not think of leaving Scotland without waiting upon Mr. Symington, in the hope of seeing the boat and machinery, and procuring some information as to the principles upon which it was moved. He remarked, that however beneficial the invention might be to Great Britain, it would certainly be of more importance to North America, considering her many navigable rivers and lakes, and the ease with which timber could be procured for building such vessels and supplying them with fuel. He thought fit further to say, that the usefulness of steam vessels in a mercantile point of view

could not fail to attract the attention of every observer; and that if he was allowed to carry the plan to North America, it could not but turn out to Mr. Symington's advantage, as if inclined for it, or his other engagements would permit, the constructing, or at least the superintending the construction of such vessels, would naturally devolve upon him. Mr. Symington, in compliance with the stranger's earnest request, caused the engine fire to be lighted up, and the machinery put in motion. Several persons entered the boat, and, along with Mr. Fulton, were carried from Lock No. 16, where she then lay, about four miles west; and returned to the place from whence they had started in one hour and twenty minutes (being at the rate of six miles an hour), to the astonishment of Mr. Fulton and the other gentlemen present. 1807.

"Mr. Fulton asked and obtained leave to take notes and sketches of the form, size, and construction of the boat and apparatus; but he never afterwards communicated with Mr. Symington."*

Further and more ample testimony to the truth of Fulton having thus ascertained, by personal investigation, a knowledge of the means by which Symington propelled his boat, might be readily given; but the following extracts, which fully corroborate the preceding statement, will suffice to establish the fact.

The first in an affidavit. "Robert Weir, residing at Kincardine, in the county of Perth, in that part of the united kingdom called Scotland, maketh oath, and sayeth, That he is acquainted with William Symington, engineer, at Falkirk. That he was employed by him for several years. That in the year 1801, he remembers of Mr. Symington erecting a boat and fitting a steam engine into it, and dragging two vessels along the Forth and Clyde Canal, by means of the said steam boat. That the deponent was employed as engine fireman on board of the said boat. That during the experiment, the now deceased Thomas Lord Dundas and several gentlemen were on

* Bowie on Steam Navigation, p. 14.

1807. board the steam boat. Deposes that the following persons, now living, were also on board, viz.—Alexander Hart and John Allen, shipbuilders, Grangemouth, and John Esplin and William Gow, shipmasters there. That some time after the first experiment, while the boat was lying upon the Canal, at Lock No. 16, it was visited by a stranger, who requested to see the boat worked.

"That the said William Symington desired the deponent to light the furnace, which was done, and the stranger was carried about four miles along the canal, and brought back. That this stranger made enquiries both as to the mode of constructing and of working the boat, and took notes of the information given him by the said William Symington.

"That the deponent heard the stranger say his name was Fulton, and that he was a native of the United States of America. That the deponent remembers Mr. Symington remarking, that the progress of the boat was much impeded by the narrowness of the canal, to which Mr. Fulton answered, that the objection would not apply to the large rivers of North America, where he thought the boat might be used to great advantage.

"Sworn at Blair Castle, in the county of Perth, upon the twenty-third day of October, one thousand eight hundred and twenty-four, before me, one of his Majesty's Justices of the Peace for the county of Perth.

(Signed) "Robert Weir.
"Robert Dundas, J. P."

The next testimony is that of Mr. Jacob Perkins, a native of America, who has long resided in this country, and who has acquired a high reputation by his mechanical ingenuity. Mr. Perkins, in reply to a letter from Mr. Bowie on the subject, thus writes:—

1807.

" 21, Great Coram Street, 15th Feb. 1834.

" Dear Sir—In answer to yours of the 5th instant, I can only say, that so much time has elapsed since any conversation passed between Mr. Fulton and myself on the subject to which you allude, that I have but an indistinct recollection of what occurred between that gentleman and myself respecting his first idea as to the practicability of Steam Navigation. The impression, however, is on my mind, that he received his first hints from some experiments that he had witnessed in Scotland. I do not remember his ever having mentioned any one being concerned in making these experiments in that country but Mr. Symington.

" I remain yours very truly,

(Signed) " JACOB PERKINS.

" Mr. Bowie."

After witnessing the experiments of Symington, Mr. Fulton ordered from Messrs. Boulton and Watt, of Soho, near Birmingham, a steam engine for propelling a boat intended to be built in America.

This engine reached its destination before the *Clermont* was launched, and, with the assistance of the working engineers who had accompanied it from Soho, it was fixed in that boat.

The engine differed very little in size from that of the *Charlotte Dundas*, whose piston had a 4-foot stroke, and was 22 inches in diameter, whilst that of the *Clermont* had also a 4-foot stroke, and was 24 inches in diameter. Such similarity in the dimensions of these engines cannot easily be imagined to have arisen accidentally.

Now if Fulton had been, as has been assumed, the inventor of Steam Navigation, it is clear that he must have made the discovery before the period at which the *Clermont* was launched; and having made so great a discovery, one would be led to imagine that he would have secured to himself, by letters patent, at an early period, that

1807. particular arrangement of machinery by which Steam Navigation became practicable, and was subsequently introduced in America.

But such is not the case, for it was not until the 11th February,
1809. 1809, that he obtained his first patent in America for propelling, and the second for the same purpose he obtained on the 2nd Oct. 1810.

These specifications are too long, and accompanied by too large a number of drawings, to be here inserted at length. The following extracts will sufficiently explain, in his own words, the grounds on which he founded his claim to the invention :—

" I, Robert Fulton, native of Pennsylvania, citizen of the United States of America, and now residing at Kalorama, in the district of Columbia, give the following description of my invention or discovery for constructing boats or vessels which are to be navigated by the power of steam engines; believing myself to be the original inventor or discoverer of the following combinations, and the first who has laid down rules that will secure success in building such boats or vessels; no patent or publication having hitherto appeared, in which exact and mathematical principles are explained to guide artizans to success in works of this kind. I do not consider the successful construction of a steam boat to depend on any new form of steam engine or boiler; such combination will relate to the engine or boiler only, and cannot be an improvement of importance, unless they produce a greater power, with less fuel, than is produced by those which are made on the principle of Messrs. Boulton and Watt's steam engine; which principle of steam engine I prefer to all others for obtaining the necessary power to drive the boat; and I assert, that to give the greatest velocity to a boat with given power of a steam engine, she must be built on the following principles :—

" First, The boat must be so constructed that, for any determined weight she is destined to carry, she should present the least possible resistance. For this purpose her bow and stern should be sharp to angles of at least 60 degrees, and as much sharper as consistent with strength.

"Secondly, She may be made of a length that her friction will equal her plus and minus pressure." (Here follow diagrams of the forms of bodies which had been used for the purpose of ascertaining which form could be passed through the water with the least power; also tables connected therewith. These diagrams and tables are accurately copied from those published by the late Colonel Mark Beaufoy, who made experiments in Greenland Dock, near London, under the direction of a Society for the Improvement of Naval Architecture. The drawings attached to this first Specification are twelve in number; and it should be stated that Fulton makes the following acknowledgment on the second sheet:—'A table of the resistance of bodies moved through the water, taken from experiments made in England by a Society for improving Naval Architecture, between the years 1793 and 1798.') "After such length has been established, should it be desirable to have a more powerful engine, and a boat to carry a greater cargo, it will be optional to make her longer, and thereby increase her friction, or load her to draw so much water that her plus and minus pressure will equal the friction of the intended additional length: in both cases the total resistance will be equal while the boat moves in a right line in still water; but loading will be preferable to increasing her length, as the demonstrations on this principle will hereafter exhibit. 1809.

"Thirdly, I give the preference to a water wheel or wheels with propelling boards, to gain a purchase on the water, which wheel may have any number of arms and propelling boards: from three to twenty-eight arms and propelling boards to each wheel will be found to apply the power of the engine to great advantage; each wheel may be from six to twenty feet diameter; that will depend on the speed which the boat is to run, as will be seen hereafter. From 12 to 15 feet will usually be the best diameter. Previous to adopting wheels, I made experiments on paddles which formed nearly an eliptical movement, as delineated in drawing first, figure first, on endless chains, with propelling boards, as indicated in figure second;

1809. on flyers, like those of a smoke-jack, figure third; none of which are so simple and effectual as wheels; and I mention this to show that I have not adopted wheels until convinced of their superior advantages, which the calculations hereafter will demonstrate.

"Fourth, When the speed which the boat is to run in still water has been determined, whether 1, 2, 3, 4, 5, or 6 miles an hour, and the power to drive her the intended velocity has been calculated, the diameter of the cylinder of the steam engine, the length of the stroke of the piston, the strength of the steam to be used, and the number of strokes which the piston will strike in a minute, must be calculated, to give the power required.

"That any determined power of steam engine shall drive a given boat with the greatest speed which such engine can effect, will depend on certain exact proportions, which shall hereafter be explained, between the shape of the bow and stern of the boat, her length, draft of water, velocity, and total resistance; and the diameter of her wheels, the velocity of their periphery, and the square feet of their propelling boards, which continually act against the water. A boat may be moved by the power of a steam engine although exact proportions are not observed; but to drive her with the greatest speed, with a given power, the proportions must be adhered to.

"It consequently follows, that they who attempt to construct steam boats without knowing the proportions and velocities, proceed without any certain guide, and cannot give rules to secure success in building and navigating steam boats of various dimensions and velocities, so as to apply the power of the engine to the greatest advantage.

"Be it, therefore, known that I found my claim to exclusive right for my invention or discovery, not only to my particular mode of combining boats and machinery, but, also, to the necessary form of the boat or boats, to the size of the propelling boards, and the velocity they should run, proportioned to the shape of the bow and stern of the boat, her draught of water, velocity, friction, and total resistance, and to the calculations on the power of the steam engine to give

the whole the necessary velocity. The successful construction of steam boats depends on these parts being well proportioned, whether wheels or any other propellers be used, with the right proportion of the parts above mentioned. Steam boats may be navigated by the propelling power of wheels, endless chains, or paddles; but without the proportions which shall hereafter be explained, they cannot be successfully navigated, with either wheels, endless chains, paddles, or any other mode of taking the purchase on the water: it therefore follows that an exact description of the form of the boat and of the proportions and velocities of the machinery, are the most important parts of this invention or discovery, in addition to which I have given modes of combining the boat and mechanism so as to secure success in building steam boats for passengers or merchandize." 1809.

Next follow the demonstrations from Beaufoy, and his own calculations founded upon them, occupying several pages, to show how a boat and machinery should be constructed on his principles, to go one mile an hour, two miles an hour, three miles an hour, four miles an hour, five miles an hour, and lastly, six miles an hour, with tables for each rate of velocity.

To show in what manner Mr. Fulton calculated his tables, (which is all in fact upon which he could rest any claim to originality), I will give the calculation for a boat intended to run one mile an hour.

"The plus and minus pressure of 1 foot, 0·88 lbs. which, multiplied by 36 feet, the boat's bow, is	31·68 lbs.
Friction on 848 feet of bow and stern, at 0·70 lbs. for 50 square feet, is	11·90
Friction on 2,200 square feet of the body of the boat is	30·80
Total resistance of the boat	74·38
A like power for the propellers	74·38
Total power	148·76

"This power must be felt at propellers repelling water one mile an hour, or one foot and a half a second, which is one-fourth slower than the motion of the piston; consequently one-fourth may be de-

1809. ducted from 148·76, leaving 111·57 the power of the engine: a cylinder 4 inches diameter, equal 16 round inches, and 8 lbs. to the inch, gives 128 lbs., which is sufficient power. The periphery of the propeller wheels must run 2 miles an hour, or 3 feet a second, equal 180 feet a minute. If $11\frac{1}{2}$ feet diameter, $34\frac{1}{2}$ feet round, $5\frac{1}{4}$ revolutions in a minute gives 181 feet: the engine strikes 15 double strokes a minute, the wheels make $5\frac{1}{4}$ revolutions in a minute: this is a proportion of near 3 to 1; hence the first mover or *pinion* from the engine may be 2 feet diameter, the wheel on the water wheel shaft 6 feet diameter, as in drawing 4, figure 1: the total resistance of the boat is 74·38 lbs.; one square foot of propellers running 1 mile an hour is 3·25; resistance 23 feet will give 74·75: this is $11\frac{1}{2}$ feet in each propeller."

The calculations for boats which are to go 2, 3, 4, 5, or 6 miles an hour are made upon the same principle. In each the cylinder is squared, which gives its capacity as stated in round inches, and the wheels are always to go double the speed of the boat.

Immediately following the sixth calculation he says,—"These demonstrations show the little refinement of combination and calculation which is necessary to construct a steam boat to run 1, 2, or 3 miles an hour; 4 miles an hour requires exact proportions and good execution; 5 miles an hour is difficult to effect with the most accurate proportions and perfect workmanship. As to 6 miles an hour, were it attempted and to succeed, I should consider it more a work of curiosity than utility; as I do not believe it possible to build a steam boat with any engine which is now known, to run 6 miles an hour in still water, and carry either passengers or cargo to pay the expenses. I prefer making my calculations to run from 4 to $4\frac{1}{2}$ miles an hour in still water; whatever may be the tide or current in her favour, must be added to her velocity in still water: whatever the tide or current may be against her, must be deducted from her speed in still water."

Mr. Fulton then closes his first Specification in the following manner:

1809.

"*Recapitulation of the Combinations and Discoveries which I have made and consider as essential to the successful Construction and Navigation of Steam Boats.*

"First, The method of ascertaining the total resistance of the boat when running from 1 to 6 miles an hour. Second, The demonstrations on the superior advantage of a propelling wheel or wheels for taking the purchase on the water. Third, The demonstrations on the proportions which the propelling boards should bear to the total resistance of the boat, and the velocity which they should run, compared with the intended velocity of the boat. Fourth, The method of calculating the power of the engine to supply the loss of power on the propellers, and overcome the total resistance of the boat while running from 1 to 6 miles an hour. The development of these principles is indispensable to the most perfect construction of steam boats: it is owing to a want of an accurate knowledge of these principles that the essays on steam boats which have been made in different countries for thirty years have hitherto failed.

"It consequently follows that those who are not possessed of this knowledge cannot make a steam boat to run 4 miles an hour unless by chance, nor can they give rules to secure success in building steam boats of various dimensions and velocities.

"In the development of the principles, velocities, and power being ascertained, the remainder is nothing more than mechanical combination, which may be varied in a variety of methods, but which cannot be considered an improvement unless a greater speed be obtained with less fuel than by the methods I have described.

"Having been the first to discover and describe the exact principles and proportions on which steam boats should be built, and having given the mechanical combination, the utility of which is proved by practice; I shall consider every attempt to construct such

1809. vessels on those principles as an infringement on my rights. As to the mechanism, I have thought it sufficient to give only one mode of combining steam boats for passengers, for merchandize, and for ferries, in each of which sails are used as an aid to the engine.

(Signed by) " Robert Fulton.

Witnessed by
(Signed) " John R. Livingstone,
" Maturin Livingstone."

Mr. Fulton's second specification is little more than a recapitulation of the first, and his claims are to a great extent similar. It commences—

" I, Robert Fulton, &c. give the following description of my inventions and discoveries for constructing boats or vessels which are to be navigated by the power of steam engines, believing myself to be the original inventor and discoverer of the following combinations. To obtain the power for driving the boat, I make use of Watt and Boulton's steam engine, (for the particulars of which he refers to an English work, the 'Repertory of Arts,' vol. vi.) or any other steam engine of equal power, my claim to invention not extending to the steam engine, but to the proportioning, combining, and applying it in such a manner to a boat or vessel of such dimensions as to drive her to a certainty more than 4 miles an hour in still water.

" After having determined the length, width, and draught of water of the boat, the details of my patent, dated February 11, 1809, will show the mode for ascertaining her total resistance while running 1, 2, 3, 4, 5, or 6 miles an hour in still water; also, the mode for proportioning the power of the engine, the velocity of the piston, and diameter of the water wheels, with the velocity of their periphery and the size of each of their propellers, to overcome any given resistance of boat while running 1, 2, 3, 4, 5, or 6 miles an hour in still water.

" Having been the first to demonstrate the superior advantage of a

water wheel or wheels, I claim as my exclusive right, the use of two wheels, one over each side of the boat, to take the purchase on the water: to turn such wheels forwards or backwards, I claim as my combinations and exclusive right the following modes for communicating the power from the piston-rod of the steam engine to them. 1809.

"First, by two triangular beams which are described in the details of my patent dated February 11, 1809, and only mentioned here to bring together my several combinations.

"Second, by wheels without a beam: in this case a crank or crank wheel is on each side of the cylinder, to which shackle bars descend from the cross bar on the top of the piston rod, which, turning the cranks, the water-wheels, being connected with the axis, turn also: those two crank wheels drive two wheels of equal diameter, from which a movement may be taken to work the air pump; which two wheels drive two pinions, on the shaft of which is the fly wheel or wheels.

"Third, by means of a cast or wrought iron beam on each side of the cylinder: near the bottom of the boat, from a cross bar on the top of the piston-rod, a shackle bar descends on each of the cylinders, and connects with the ends of the beam: a shackle bar rises from the other end of each beam to a cross bar, from which cross bar shackle bars descend, to turn two cranks or crank wheels, to the axles of which the water-wheels are connected: the two crank-wheels drive two pinions, on the shaft of which the fly-wheels are fixed.

"Fourth, by means of a cast or wrought iron beam above the cylinder, which receives motion from the piston rod: from the other end of the beam a strong shackle bar gives motion to a crank, on the axle of which, or connected with it, are the two water-wheels: from the crank shaft a movement may be taken to turn the fly-wheels, or, by using sun and planet wheels, the shaft of the sun wheel will act as a fly, and drive the water-wheels by means of a pinion on the sun wheel shaft, and a wheel on the water-wheel shaft: thus, if required, reducing the revolutions of the water-wheels to half the number of

1809. revolutions of the fly; or if the water-wheels are put on the shaft of the sun wheels, and weighted with iron, they will act without any other fly, but not to such advantage as with a fly and water-wheel; because a rapid moving and small propellers is a loss of power. I use coupling boxes or any other means to throw the propelling wheels in or out of gear, or to throw one wheel out and work the other, as may be required:—this convenience in combining the machinery of steam boats I claim as my discovery and exclusive right, whatever may be the mode by which it may be executed. I also claim as my invention and exclusive right, the guards which are round the outside of the propelling wheels, which guards may support the outside gudgeons of the said propelling wheels, and give the convenience of a deposit for fuel, bins or lockers for various materials, water-closets for the convenience of passengers, and steps to enter from and go into the row-boats; which guards protect the wheels from injury by wharves, vessels, &c. &c. I claim as my invention to project from the side or sides of the steam boat, beams or timbers, or spars, or fenders of wood or iron of any kind, to guard or protect the water-wheels from injury by wharves, vessels, &c. &c. I also claim the exclusive right to cover the water-wheels, whether by boards, netting, or grating, canvass, or leather, or in whatever manner it may be done, to prevent them throwing water on deck, or entangling in ropes. I claim as my invention to place the tiller and steering wheel, and pilot and steersman, further forwards in steam boats than is usual in other vessels; the necessity of which is, that the boat being long, and the deck covered with passengers, the pilot could not see forward unless near the middle of the deck: hence any one who moves a steersman further forward in a steam boat than is usual in other vessels, shall be considered as using this part of my invention in the convenient arrangement of steam boats. I claim as my invention the straight and diagonal braces which I have placed in the sides of my steam boats to give them strength to support the weight of the engine, boiler, and machinery, and which braces extend

from a line behind the boiler to a line forward of the machinery. I claim as my invention to set the engine and machinery in a frame which is laid on the bottom of the boat, which frame must be of a length, breadth, and strength to bear the weight of the machinery and working of the engine, and divide it over so great surface of the boat as to do her no injury. I also claim as my invention to accommodate a steam engine to a boat, my mode of setting the air pump and machinery behind the cylinder, that is, on the side opposite the hand gear, and which is the reverse of the mode in which engines are put upon land. 1809.

"I claim as my invention and exclusive right the combination of sails with a steam engine to drive a boat, I being the first who have done so, and proved by practice the utility of the union of the two powers of wind and steam: hence, as a boat may be rigged a variety of ways, my invention is not for any particular mode of rigging, but for the discovery and proof by practice, of the importance of using sails with a steam engine to drive a boat. I claim as my invention my particular mode of proportioning and placing a propelling wheel or wheels in the stern of a boat, which wheel or wheels are in a chamber formed by the two sides of the boat, extending aft one or more feet further than the extreme diameter of the propelling wheel, to each of which side projections there is a rudder, which two rudders, connected by a cross bar working on pivots, cause them to move together, and parallel to each other: from this cross bar, or from the rudders, the ropes or chains for steering lead on to the pilot.

"To put a propelling wheel or wheels in motion at the stern of a steam boat, a movement may be carried from the engine to it or them by bevel wheels and shafts to opposite the centre of the axle of the propelling wheel, and between two wheels, or by bevel wheels and a shaft on one side of one propelling wheel, or by a triangular beam at the engine, and long shackle bars moving in guides on rollers, and which communication may be performed by shackle bars

1809. leading along the centre of the boat, turning a crank between the two wheels, or by a shackle bar on each side of the propelling wheel, each acting on a crank on each end of the shaft of the propelling wheel."

Further to elucidate this portion of his Specification, Mr. Fulton gave the following example:

"My first steam boat on the Hudson's River was 150 feet long, 13 feet wide, drawing 2 feet of water, bow and stern 60 degrees; she displaced 36·40 cubic feet, equal 100 tons of water; her bow presented 26 feet to the water, plus and minus resistance of 1 foot; running 4 miles an hour.

"12·37 lbs. multiplied by 26, the bow of the boat	321 lbs.
Friction on 2,380 superficial feet of bottom and sides, at 7·50 lbs. or 50 superficial feet	352
Total resistanee of the boat, running 4 miles an hour . . .	673
A like power for the propellers	673
Total power felt at the propellers	1,346
The boat running 4 miles an hour is 6 feet a seeond; this is three times faster than the piston: hence, multiplied by	3
Necessary power of the engine, the piston running 2 feet a second.	4,038 lbs.

"This will require a 22-inch cylinder, allowing 9 lbs. purchase to the round inch: this engine would not occupy in the boat more space than in the small one, and it would not weigh 2 tons more than the 17-inch cylinder: hence, say weight of engine 22 tons, weight of boat 40 tons, total 62 tons: this leaves 38 tons for passengers or merchandize, with ample space, before it could bring her down to 2 feet in the water; but drawing not more than 18 inches before cargo or passengers were in, and her resistance being diminished one-third, the above power would drive her $4\frac{1}{2}$ miles an hour. The two preceding examples exhibit in a clear point of view the advantage to be gained in building a large boat, to carry a large and powerful engine.

"All persons who have tried experiments on steam boats before me, seeing the weight which loaded the boat, and great space which was occupied when Watt and Boulton's engine was adopted, attempted to construct engines, powerful, lighter, and more compact than those of Watt and Boulton; and thus they endeavoured to accommodate the engine to a small vessel, hoping by that means to drive her 4 miles or more an hour; or if they did not endeavour to compress and lighten the engine, they always built their boats and engines on too small a scale, and thereby made it impossible to gain a velocity of 4 or $4\frac{1}{2}$ miles an hour, in consequence of working on erroneous principles. I discovered this error, and not attempting to accommodate an engine to a small boat, I constructed a large boat, and accommodated its dimensions to a large and powerful engine." 1809.

This Specification is thus concluded.

"I claim the exclusive right to construct steam boats of a size exceeding a displacement of 50 tons of water, by which means I am enabled to accommodate the boat to the engine, and produce a velocity from 4 to 5 or 6 miles an hour.

(Signed) "Robert Fulton.

Witness, (Signed)
"John Nichelson.
"Geo. Lion."

Fulton's Specifications are here given at much greater length than was at first intended, as any attempt at abridgment, however faithfully executed, might be viewed with suspicion. His claims are set forth in his own words; and from these it will be clearly evident that *he was not the inventor of the present system of Steam Navigation.* His calculations of forms and proportions were wholly founded on those of Colonel Beaufoy; he made use of Boulton and Watt's steam engine, including the sun and planet motion, to propel his boats; and amply availed himself of the invention of Symington, as specified by him, and actually carried into practice with the *Charlotte*

1809. *Dundas.* Fulton's patents and specifications must therefore be considered either as mere importations, borrowed (in patent phraseology) from "foreigners residing abroad," or as bare-faced plagiarisms. The dimensions of his first boat, as given in the second specification, differ from those furnished by his biographer, and by Mr. Charles Brown, by whom the vessel was built; and it is even admitted, that for the success of his experiments with the *Nautilus*, which occupied so many years of Fulton's life, he was mainly indebted to the invention of Mr. D. Bushnell.*

Prior to the practical working of any steam boat in Europe, Mr. Charles Brown had built for Fulton the following vessels:

NAMES.	Length.	Breadth.	Depth.	Cylinder.	Stroke.	Tonnage.	When built.	How employed.
	Feet.	Feet.	Feet.	Inch.	Feet.			
Clermont, or North River	133	18	7	24	4	160	1806	On the Hudson River.
Rariton	...	...	...	...	...	120	1807	On the Rariton River.
Car of Neptune . . .	175	24	8	33	4·4	295	1807	On the Hudson River.
Paragon	173	27	9	32	4	331	1811	On the Hudson River.
Fire-Fly	100	19	7	20	3·9	118	1812	From New York to Newburgh.
Jersey Ferry Boat . . .	78	32	7	20	4	118	1812	By the Ferry Company.

In concluding this account of Fulton's services in advancing the progress of Steam Navigation, another extract from his biography is here inserted.

"On the 4th July, 1815, a vessel (of Fulton's) made a trial trip of 15 miles with steam only, at an average speed of 5½ miles an hour. She is a structure resting on two boats, separated from end to end by a channel 15 feet wide, and 66 feet long: one boat contains the cauldrons, which are of copper, to prepare her steam; the cylinder of iron, its piston, levers, and wheels, occupy part of the other. The

* See Colden, &c. &c.

water-wheel revolves in a space between them. She is rigged with two stout masts, has two bowsprits and jibs, and four rudders." * 1809.

Had Mr. Fulton been wholly unacquainted with the peculiar construction of the Dalswinton boat, already referred to, this would certainly have been a very remarkable coincidence.

1812.

We now reach the period which brings us to Practical Steam Navigation in Europe. On the 18th of January, 1812, Mr. Henry Bell, of Helensburgh, completed the construction of a vessel named the *Comet*, of 30 tons burden, which was effectively propelled by a steam engine driving two paddle-wheels on each of her sides. The engine was estimated at three horses' power; and the dimensions of the vessel were 40 feet in length, and 10 feet 6 inches in breadth.

The following circular, issued by Mr. Bell, will best explain his intentions with respect to this vessel:

"*Steam Passage Boat, the 'Comet,' between Glasgow, Greenock, and Helensburgh, for passengers only.*

"The Subscriber having, at much expense, fitted up a handsome vessel to ply upon the river Clyde, between Glasgow and Greenock, to sail by the power of wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about mid-day, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide.

"The elegance, comfort, safety, and speed of this vessel require only to be proved to meet the approbation of the public; and the proprietor is determined to do every thing in his power to merit public encouragement.

"The terms are, for the present, fixed at four shillings for the best cabin, and three shillings the second; but beyond these rates no-

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* Colden, p. 229.

1812. thing is to be allowed to servants, or any other person employed about the vessel.

"The Subscriber continues his establishment at Helensburgh Baths, the same as for years past, and a vessel will be in readiness to convey passengers in the *Comet* from Greenock to Helensburgh.

"Passengers by the *Comet* will receive information of the hours of sailing by applying at Mr. Houslen's office, Broomielaw; or Mr. Thomas Blackney's, East Quay Head, Greenock.

(Signed) "HENRY BELL.

"Helensburgh Baths, Aug. 5, 1812."

Mr. Bell presented his inventions for the improvement of Steam Navigation to the notice of the British Government at three different periods, namely, in 1800, 1803, and 1813, but without success. In 1803, on finding that the Board of Admiralty expressed no desire to promote his views, and still anxious that his inventions should be carried into practical operation upon an extended scale, he forwarded an account of his method of propelling vessels against wind and tide, by the application of steam power, to all or most of the European Governments, and also to the United States of America.*

No valid claim can be established in favour of Mr. Bell as the inventor of *the present system of Steam Navigation*, or for any improvements beyond those of which he had acquired a knowledge from the experiments of Messrs. Miller, Taylor, and Symington. In fact, Symington's boat, the *Charlotte Dundas*, which had been frequently inspected by both Bell and Fulton, was superior in its mechanical arrangements to either Fulton's *Clermont*, or Bell's *Comet*, as may be readily seen by an inspection of the drawings.

What Fulton and Livingstone succeeded in accomplishing in America, Bell accomplished in his own country and in Europe, and

* Tredgold on the Steam Engine, pp. 44, 45, and 470.

thus became instrumental in the introduction of Steam Navigation at an early period. 1812.

Two letters are here introduced, for the purpose of showing that an intimacy and correspondence existed between Fulton and Bell.

In the year 1816, Mr. Bell addressed the following letter to the Editor of the "Caledonian Mercury:"—

"Sir,—I observed in your paper lately a paragraph respecting steam boats, in which the Americans claim the right of the discovery which has become of so much utility to the public. On this account I propose to give you a full statement of what I conceive to be the truth. Mr. Miller, of Dalswinton, first wrote upon the method of moving or impelling vessels or rafts through water by paddles, wrought by a capstan, or by the wind, in the manner of a windmill, which idea he afterwards gave to all the different Courts in Europe.

"It will be recollected by most people in this country, that the French proposed to erect rafts for conveying troops to invade this country, by means of Mr. Miller's windmill capstan plan; for it may be stated that this gentleman built two vessels at Leith, and put them in motion upon his new improvement, and even sent one of them to the King of Sweden as a present.

"After this, he thought that an engine could be so constructed as to be applied to work his machinery for the moving of his paddles; and accordingly he employed an engineer to put his plans in execution; but they failed for want of being properly executed. But to give you a more correct account of the manner Mr. Fulton, the American engineer, came to the knowledge of steam boats, that gentleman had occasion to write me about the plans of some machinery in this country, and beg the favour of me to call on Mr. Miller, of Dalswinton, and see how he had succeeded in his steam boat plan; and if it answered the end, I was to send him a full drawing and description of it, along with my machinery. This led me to have a conversation with the late Mr. Miller, and he gave me every information I could wish for at the time. I told him where, in my opinion,

1812. he had erred, and was misled by his engineer; and at the same time I told him, that I intended to give Mr. Fulton my opinion on steam boats.

"The friends of Mr. Miller must have amongst their papers Mr. Fulton's letter to me; for I left it with Mr. Miller.

"Two years thereafter, I had a letter from Mr. Fulton, letting me know that he had constructed a steam boat from the different drawings of the machinery I had sent him out, which was likely to answer the end, but required some improvement on it. This letter I sent to Mr. Miller for his information, which must, also, be amongst his papers.

"This letter led me to think of the absurdity of writing my opinion to other countries, and not putting it in practice in my own country; and from these considerations I was roused to set on foot a steam boat, for which I made a number of different models before I was satisfied. When I was convinced that they would answer the end, I contracted with Messrs. John Wood and Company, Ship-builders in Port Glasgow, to build me a steam vessel according to my plan, 40 feet keel, and 10 feet 6 inches beam, which I fitted up with an engine and paddles, and called her the *Comet;* because she was built and finished the year that a comet appeared in the north-west part of Scotland. This vessel is the first steam boat built in Europe that answered the end, and is at this present time upon the best and simplest method of any of them; for a person sitting in a cabin will hardly hear the engine at work. She plies on the Frith of Forth, betwixt the east end of the great canal and Newhaven, near Leith. The distance by water is 27 miles, which she performs, in ordinary weather, in $3\frac{1}{2}$ hours up, and the same down. There were many attempts to make steam boats in this country before this one, but none of them ever answered the end; and even three years after the *Comet* was set a sailing, there was a number of our first-rate engineers joined together, and obtained a patent for what they conceived a new discovery on the paddles for impelling the vessel forward.

"They were disappointed in their plan, and had to return to the model of the *Comet*." 1812.

And in the year 1824, Mr. Bell also addressed a letter to John Macneil, Esq., of Glasgow, as follows :—

"Mr. John McNeill. "Helensburgh, 1st March, 1824.

"Sir,—I this morning was favoured with your letter; and in answer to your enquiries anent the late Mr. Robert Fulton, the American engineer,—his father was from Airshire, but what place or family I cannot tell; but he was born in America. He was at different times in this country, and stopped with me for some time. He published a treatise on canal declining railroads afterwards. I have not his book, but you will find it at Mr. Taylor's, stationer, London, price 21*s*. He published it in this country in 1804, I think; for in the latter end of the year 1803 he on his way to France called on me, and on his return in 1804. He was brought up in the line of a painter, and was the best hand-sketcher, and likewise a good miniature painter.

"He was not brought up an engineer; but he was employed to come to this country to take drawings of our cotton and other machinery; that led him to become a civil engineer, and he was quick in his uptake of any thing.

"When I wrote to the American Government on the great utility that Steam Navigation would be to them on their rivers, they appointed Mr. Fulton to correspond with me; so in that way the Americans got their insight from your humble servant,

(Signed) "Henry Bell."*

"At the same time that Mr. Bell was experimenting upon the Clyde, a Mr. Dawson was, also, making some experiments in Ireland,

* "Memoir by Patrick Miller, Junior."—Edinburgh New Philosophical Journal, July, 1827.

1811. and according to his own statement, had in 1811 built an experimental steam boat of 50 tons burden, and worked her by a small high-pressure steam engine: by a most extraordinary coincidence, he, also, named his vessel the *Comet*. In 1818 the same individual established a steam packet on the Thames, to ply between Gravesend and London, which was the first that did so for public accommodation, although a Mr. Lawrence, of Bristol, who introduced a steam boat on the Severn, soon after the successful experiments on the Clyde, had her carried on the canal to London, to ply on the Thames; but from the opposition of the watermen to the innovation, he was in the end obliged to take her to her first station. This vessel was afterwards sent to Spain, and plied between Seville and St. Lucar."*

Notwithstanding the meritorious character of Bell's enterprize, his speculation for the first year turned out a losing one; "for so great," says he, "was the prejudice against steam boat navigation, by the hue and cry raised by the fly boat and coach proprietors, that for the first six months very few would venture in her. But in the course of the winter of 1812, as she had plied all the year, she began to gain credit; as passengers were carried 24 miles as quick as by the coaches, and at a third of the expence, besides being warm and comfortable. But even after all, I was a great loser that year. In the second year, I made her a jaunting boat all over the coasts of England, Ireland, and Scotland, to show the public the advantage of steam boat navigation over the other mode of sailing."

"Previously to the voyages of the *Comet*, the average number of travellers between Greenock and Glasgow was eighty up and eighty down; in four years afterwards it was not unusual for five or six hundred passengers daily to enjoy the healthful amusement of a water excursion, and the enchanting beauties of the Clyde."†

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* Stuart, vol. ii. p. 525. † Ibid.

Shortly after this period, steam navigation by paddle-wheels became general in Great Britain. 1811.

"The first steam vessel which crossed the Atlantic was the *Savannah*, built and equipped at New York. This vessel proceeded in 1819 from New York to Liverpool, without stopping at any intermediate port: she then went to St. Petersburgh, touching at Copenhagen, and subsequently recrossed the Atlantic. Steam was employed during only a part of these voyages. She was of 350 tons burden, and the steam apparatus occupied the greater part of the hold from the main-mast to the fore mast, a small space being reserved at each side for the stowage of coals, which in this engine amounted to about ten tons per day; and from this it will be seen that little room was left for the cargo. 1819.

"The paddle-wheels in the *Savannah* were fixed to a cast iron axletree, passing through the sides of the vessel above the bends: nearly the whole of each wheel was constructed so that it could be taken to pieces, and removed in the event of bad weather; two principal arms, which were also of cast iron, being the only parts which would then remain, and these in high seas could be placed in a horizontal position, producing little inconvenience in the navigation of the vessel."*

"To Sebastian Cabot, who was born at Bristol in 1467, may be assigned the glory of discovering the Continent of North America. He was the son of John Cabot, a Venetian, who resided several years at Bristol: his father gave Sebastian an excellent education to qualify him for the profession of a mariner, and before he was twenty years of age made him his companion in several voyages. They sailed from Bristol in the Spring of 1494, and pursuing their course with favourable winds, on the 24th of June saw Newfoundland, to which they gave the name of *Prima Vista*, or 'first seen.'

"Cabot the father dying soon after, a new patent was granted to

* Partington, page 60.

1819. his son Sebastian, by Henry VII., to proceed again in quest of discoveries, and he sailed from England on the 4th of May, 1497, before Columbus had commenced his third, the most important of all his voyages. Cabot sailed to a latitude as high as 67 deg. 30 min. north, from whence shaping his course southerly, he came down to 56 degrees, after which he explored the whole coast of North America, as low as 38 degrees. This part of the Continent he expressly says was afterwards named Florida. He returned to England with a rich cargo of productions brought from the part of the new world he had discovered.

"Cabot was afterwards employed in exploring the northern seas of Europe, in order to open new channels of commerce. Under the patronage of Henry VIII., he made the first voyage to Russia, and was appointed Governor of the first Russian Company of English Merchants. After a most active life, beneficial to himself, and both useful and honourable to his country and mankind, he died at a very advanced age.

"The spirit of adventure to which his discoveries gave birth among the English, led the way to their commerce, naval power, and glory."*

The preceding extract is given as an introduction to the remarkable fact, that from the port of Bristol the first practical ocean-going steamer, the *Great Western*, propelled by paddle-wheels, steered her course across the Atlantic; and also at a subsequent period, the *Great Britain*, propelled by a screw—thus establishing the usefulness of each mode of propulsion for the navigation of the ocean.

The *Great Western* made her first trip to America in 1838,† and the *Great Britain* made her first voyage out in July, 1845.

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* Kett's Elements, vol. i. p. 551.

† It should be noted that at the same time the *Sirius* made an experimental steam trip from Cork to New York; and although she had the start by a few days, she only reached that port on the same day as the *Great Western*.

The first, and even up to the present time, the only steam vessel 1819.
that has circumnavigated the globe, is her Majesty's steam sloop of war *Driver*. She left England on the 16th March, 1842, under Commander Harmer, who died in China. Captain Hayes then took the command of her, and brought her home.

After leaving England, she touched at the following places :—The Cape of Good Hope, the Mauritius, Singapore, and Hong Kong. Between the 5th of August, 1842, and the 9th of June, 1845, she was employed in making frequent passages from port to port in China: from China she went to Borneo, Trincomalee, and Bombay; she then returned to Trincomalee, and proceeded from there to Singapore, Manilla, and Hong Kong.

On the 27th September, 1845, she sailed from Hong Kong, attempting the eastern route to New Zealand; but when she arrived to the eastward of the Bashee Islands, she encountered a typhoon, lost all her sails, sprung a leak in two of her boilers, and sailing down the China Seas, was compelled to bear up for Singapore, and repair defects. She then steamed through the Java Seas to Sourabaya, and was subsequently compelled to anchor at Pyon, in the Island of Lumbock, to repair boilers. From Pyon she proceeded to Swan River, thence to Hobart Town, Sydney, and to the Bay of Islands in New Zealand, where she was employed in making passages from port to port, from the 19th of January, 1846, to the 18th January, 1847. On the 28th of that month she left New Zealand, and arrived at Rio in 51½ days; and from Rio she reached England in 48 days. Owing to occasional want of fuel, leakage of boilers, and other causes, steam was not used throughout the whole of each of her voyages. She was longer in commission than any vessel since the Peace, namely, five years and nine months, during which period she travelled 75,696 miles.

It has been already stated that Bramah, in 1785, patented a submerged propeller, on the principle of the sails of a windmill, or of the blades of a smoke-jack. William Littleton patented a screw

1819. propeller of three blades in 1794, and experimented with a copper screw so formed, as described by Colonel Beaufoy. Edward Shorter also patented a screw propeller in 1800, and which was successfully tried by manual power to move vessels of war in 1802. Mr. Samuel Brown had a boat expressly built for being propelled by a gas vacuum engine (of which he was the inventor), made to drive a two-bladed submerged propeller in the bow of the boat, by which a speed of from 6 to 7 miles an hour was obtained. Yet, notwithstanding these meritorious efforts to accomplish the successful introduction of the use of the screw propeller, this instrument did not come into practical use until a very recent period, when its merits as a propeller were for the first time fully demonstrated and carried into successful operation by Captain John Ericsson, C. E., in strict accordance with a peculiar arrangement of screw propellers patented by him on the 13th July, 1836.

Captain Ericsson is a native of Sweden, and held a commission in the Swedish army; but his taste for mechanics was such as to induce him to leave his native country, and establish himself in London, in partnership with the well-known establishment of Messrs. Braithwaite, in which he became a partner under the firm of Braithwaites and Ericsson.

Prior to the construction of his first vessel, he made some experiments with a model boat, which was propelled by means of a screw, in a circular bath in London. The model boat was fitted with a small engine, supplied with steam by a pipe leading from a steam boiler over the centre of the bath, and descending to within a foot of the water line, where it was branched off by a swivel joint, and connected with the engine in the boat. Steam being admitted in this pipe, the engine in the boat was put in motion, and motion was thus communicated to the propeller. This model, though less than two feet long, performed its voyage about the basin at the rate of upwards of three miles an hour.

The following account, so far as it relates to the performance of the screw boat, the *Francis B. Ogden*, is extracted from "Weale's Papers on Engineering," vol. iii. Part v. pages 1—7, under the head "*Steam Navigation.*" 1819.

"So much has been stated as to the success and efficiency of steam power, as applied to navigation and for war purposes, in the United States, that we have added to our Papers the following lecture, as written and published in America. We prefer giving the precise words, with the exception of a very short note in a subsequent page. We take leave to say, that the objects of science are best carried out by reference to such matters only as shall tend to illustrate the point in discussion.

"*A Lecture on the late Improvements in Steam Navigation and the Arts of Naval Warfare, with a brief notice of Ericsson's Caloric Engine, delivered before the Boston Lyceum, in December*, 1843, *by John O. Sargent.*

"The next step in the invention was the construction of a wooden boat, 40 feet long, 8 feet beam, 3 feet draught of water, with two propellers, each of 5 feet 3 inches diameter. 1837.

"So successful was this experiment, that when steam was turned on the first time, the boat at once moved at a speed of upwards of 10 miles an hour, without a single alteration being requisite in her machinery. Not only did the boat attain this considerable speed, but its power to tow larger vessels was found to be so great, that schooners of 140 tons burthen were propelled by it, at the rate of 7 miles an hour; and the American packet ship, *Toronto*, under the command of Captain Griswold, was towed in the River Thames, by this miniature steamer, at the rate of more than 5 English miles an hour through the water. The Engineers of London regarded the experiment with silent neglect; and the subject, when laid before 28 May.

1837. the Lords of the British Admiralty, failed to attract any favourable notice from that august body. Perceiving its peculiar and admirable fitness for ships of war, Ericsson was confident that their Lordships would at once order the construction of a war steamer on the new principle. He invited them, therefore, to take an excursion in tow of his experimental boat. Accordingly the gorgeous and gilt Admiralty barge was ordered up to Somerset House, and the little steamer was lashed alongside.

"The barge contained Sir Charles Adam, senior Lord of the Admiralty; Sir William Symonds, Surveyor of the British Navy; Sir Edward Parry, the celebrated Commander of the second North Pole expedition; Captain Beaufort, Hydrographer, and others of scientific and naval distinction.

"In the anticipation of a severe scrutiny from so distinguished a personage as the chief constructor of the British Navy, the inventor had carefully prepared plans of his new mode of propulsion, which were spread on the damask cloth of the magnificent barge. To his utter astonishment, as we may well imagine, this scientific gentleman did not appear to take the slightest interest in his explanations. On the contrary, with those expressive shrugs of the shoulder, and shakes of the head, which convey so much to the bystander without absolutely committing the actor,—with an occasional sly, mysterious undertone remark to his colleagues,—he indicated very plainly that though his humanity would not permit him to give a worthy man cause for so much unhappiness, yet that 'he could, an if he would' demonstrate by a single word the utter futility of the whole invention.

"Meanwhile the little steamer, with her precious charge, proceeded at a steady progress of 10 miles an hour, through the arches of the lofty Southwark and London bridges, towards Limehouse, and the steam engine manufactory of the Messrs. Seaward. Their Lordships having landed and inspected the huge piles of ill-shaped cast iron, mis-denominated marine engines, intended for some of his Ma-

jesty's steamers,—with a look at their favourite propelling apparatus, the Morgan paddle-wheel, (a very admirable instrument by the bye,) they re-embarked and were safely returned to Somerset House, by the disregarded, noiseless, and unseen propeller of the new steamer. 1837.

"On parting, Sir Charles Adam, with a sympathising air, shook the inventor cordially by the hand, and thanked him for the trouble he had been at in showing him and his friends this interesting experiment; adding, that he feared he had put himself to too great an expense and trouble on this occasion. Notwithstanding this somewhat ominous finale of the day's excursion, Ericsson felt confident that their Lordships could not fail to perceive the great importance of the invention. To his surprise, however, a few days afterwards, a friend put into his hands a letter written by Captain Beaufort, at the suggestion, probably, of the Lords of the Admiralty, in which that gentleman, who had witnessed the experiment, expressed regret to state that their Lordships had certainly been very much disappointed at its result. The reason for the disappointment was altogether inexplicable to the inventor; for the speed attained at this trial far exceeded any thing that had ever been accomplished by any paddle-wheel steamer on so small a scale.

"An accident soon relieved his astonishment, and explained the mysterious givings-out of Sir William Symonds alluded to in our notice of the excursion. The subject having been started at a dinner table where a friend of Ericsson was present, Sir William ingeniously and ingenuously remarked, that, 'even if the propeller had the power of propelling a vessel, it would be found altogether useless in practice, because the power being applied in the stern, it would be absolutely impossible to make the vessel steer.' It may not be obvious to every one how our naval philosopher derived his conclusion from his premises; but his hearers doubtless readily acquiesced in the oracular proposition, and were much amused at the idea of 'undertaking to steer a vessel when the power was applied in her stern.'

"But we may well excuse the Lords of the British Admiralty for

1837. exhibiting no interest in the invention, when we reflect that the engineering corps of the empire were arrayed in opposition to it; alleging that it was constructed upon erroneous principles, and full of practical defects, and regarding its failure as too certain to authorize any speculations even of its success. The plan was specially submitted to many distinguished engineers, and was publicly discussed in the scientific journals; and there was no one but the inventor who refused to acquiesce in the truth of the numerous demonstrations, proving the vast loss of mechanical power which must attend this proposed substitute for the old-fashioned paddle-wheel.

"While opposed by such a powerful array of English scientific wisdom, the inventor had the satisfaction of submitting his plan to a citizen of the New World, who was able to understand its philosophy, and appreciate its importance. I allude to a gentleman well known to many who have enjoyed his liberal hospitality in a foreign land,—Mr. Francis B. Ogden, a native of New Jersey, for many years Consul of the United States at Liverpool, and in that position reflecting the highest credit on the American name and character. Though not an engineer by profession, Mr. Ogden has been distinguished for his eminent attainments in the mechanical science, and is entitled to the honour of having first applied the important principles of the expansive power of steam, and of having originated the idea of employing right angular cranks in marine engines.

"His practical experience and long study of the subject,—for he was the first to stem the waters of the Ohio and Mississippi, and the first to navigate the ocean, by the power of steam alone,—enabled him at once to perceive the truth of the inventor's demonstrations. And not only did he admit their truth, but he also joined Captain Ericsson in constructing the first experimental boat to which I have alluded, and which the inventor launched into the Thames, with the name of the *Francis B. Ogden*, as a token of respect for his transatlantic friend. Other circumstances soon occurred, which consoled the inventor for

his disappointment in the rejection of the propeller by the Lords of the British Admiralty. The subject had been brought to the notice of an officer of the navy of the United States, who was at that time on a visit to London, and who was induced to accompany the inventor in one of his experimental excursions on the Thames. I allude to Captain Robert F. Stockton, who is entitled to the credit of being the first naval officer who heard, understood, and dared to act upon the suggestions of Ericsson, as to the application of the propeller to ships of war. At the first glance he saw the bearings of the invention, and his acute judgment enabled him at once to predict that it was destined to work a revolution in naval warfare. 1837.

"In those who are not acquainted with the character of Captain Stockton, the great rapidity of his perception, his self-reliance, and the energy with which he prosecutes his purposes, it may excite some surprise to learn, that, after making a single trip in the experimental steam boat from London bridge to Greenwich, he ordered the inventor to build for him forthwith two iron boats for the United States, with steam machinery and propeller on the plan of this rejected invention. 'I do not want,' said Captain Stockton, 'the opinions of your scientific men; what I have seen this day satisfies me.'

"It is due to Captain Stockton to state that his whole course in regard to this invention, and the introduction of it into this country (America), has been in accordance with the spirit of this remark.

"At a dinner given on this occasion at Greenwich, Captain Stockton, in his happy style, made several predictions and promises in respect to the new invention, all of which have since been realized. To the inventor he said, in words of no unmeaning compliment, 'We'll make your name ring on the Delaware, as soon as we get the propeller there.'

"The *Princeton* (war-steamer) was launched into the Delaware, and the Ericsson steam boat line is now carrying nearly the whole of the freight between Philadelphia and Baltimore, and Captain Erics-

1837. son's several iron propeller boats may be seen every day on the Delaware, carrying the rich mineral products of Pennsylvania to the east.

"But not only did Captain Stockton order, on his own account, the two iron boats to which I have referred; he at once brought the subject before the Government of the United States, and caused numerous plans and models to be made at his own expense, explaining the peculiar fitness of the new invention for ships of war. So completely persuaded was he of its great importance in this aspect, and so determined that his views should be carried out, that he boldly assured the inventor that the Government of the United States would test the propeller on a large scale; and so confident was Ericsson that the perseverance and energy of Captain Stockton would sooner or later accomplish what he promised, that he at once abandoned his professional engagements in England, and set out for the United States.

"Circumstances delayed, for some two years, the execution of their plan. With the change of the federal administration, Captain Stockton was first able to obtain a favourable hearing; and under the auspices of the present administration, the experiment of the *Princeton* has been made, and has been successful.

"It is due to the inventor to mention that the propeller, as successfully applied in the *Princeton*, is the same precisely in construction with that of the *Francis B. Ogden;* not merely in theory, but in its minute practical details.

"There is now a propeller in the Phœnix Foundry, in New York, brought over by Captain Ericsson, in the *British Queen*, in 1839, which, in all its essential parts, is a fac-simile of that in the *Francis B. Ogden*, and of that in the *Princeton*."

1837. June 3. In the "London Mechanic's Magazine," June 3rd, 1837, vol. xxvii. p. 130, is the following notice of the *Francis B. Ogden* screw steamer.

"*Captain Ericsson's New Propeller.*—The American packet ship

Toronto, of 630 tons burthen, and drawing 14 feet 6 inches water, 1837.
was on Saturday last towed down the Thames at the rate of full 4½ knots an hour, against wind and tide, by an experimental steam boat called the *Francis B. Ogden.*

" The *Francis B. Ogden* measures 45 feet in length, 8 feet beam, and draws 2 feet 3 inches water without the keel. She is of wood, and was built at Wapping, early in the Spring of 1837, by Mr. Gulliver, boat-builder: she was constructed solely for the purpose of testing Ericsson's propeller. The propelling apparatus is placed at the stern, and works entirely under the water. It consists of a peculiar application of the old and well-known principle of the water screw, by which a great propelling power is concentrated in a small space. Of the degree of power concentrated no better proof can be adduced, than the fact that the speed of 4½ knots, against wind and tide, was produced by an apparatus measuring only 5 feet 2 inches in diameter and 2 feet 2 inches wide, and worked by a high-pressure engine having two cylinders of 14 inches stroke and 12 inches diameter, and which, during the experiment, made only 60 strokes per minute, and showed a pressure of not more than 50lbs. on the square inch.

" The new propelling apparatus consists of two short cylinders made of thin wrought iron, and supported by arms of a peculiar form, which are placed entirely under the water at the stern, and made to revolve in contrary directions round a common centre.

" To the outer periphery of each cylinder there is attached a series of spiral planes or plates, which may, we understand, be placed at any desired angle, according to the effect sought to be obtained, whether it be great speed or great propelling power.

" The apparatus may be made to ship and unship at pleasure; the engine that works it may, also, be loco-moveable, so as to be worked upon deck and on any part of the deck; and in these two peculiarities we are inclined to think the chief advantage of this new step in Steam Navigation will be found to consist. Sailing vessels may by this means command all the aid that steam can give them, without

1837. divesting themselves of any of their peculiar fitness for long sea voyages, or undergoing any change in their original construction.

"We subjoin a copy, with which we were favoured, of the certificate, given by the pilot and mate of the *Toronto*, of the performance of the *Francis P. Ogden* on this occasion.

"Packet Ship Toronto, in the Thames, 28th May, 1837.

"We feel pleasure in certifying that your experimental steam boat, the *Francis B. Ogden*, has this morning towed our ship at the rate of $4\frac{1}{2}$ knots an hour through the water, and against the tide.

(Signed) "E. Nashly, Pilot.
"H. R. Hovey, Mate.

"To Captain Ericsson."

In the month of August, 1837, Mr. Charles Cheffins, of 9, Southampton Buildings, Holborn, published a lithographed plate, exhibiting a view of the apparatus used in the *Francis B. Ogden*, with a description of its construction and use. It also contained a copy of the preceding certificate.

Notwithstanding the unfavourable and discouraging result of Captain Ericsson's attempts to obtain for his discovery the patronage of the Lords of the Admiralty, it should in justice be stated that few inventions ever elicited such approving notices from the press: accounts of the several experiments appeared in the *Times* and other public journals; also in the "Civil Engineer's and Architect's Journal," the "London Journal of Arts and Sciences," the "London Mechanic's Magazine," and other similar publications.

The propelling machinery was, however, subsequently removed from the *Francis B. Ogden*, disposed of, and applied to other purposes.

1838. We now come to the period when the system of navigating vessels by means of what is technically called the Screw Propeller, with the view to supersede the old and almost universal adoption of paddle-wheels, was first brought into practical operation.

On the 7th of July, 1838, a new iron vessel, built by Messrs. Laird and Company, of Birkenhead, and fitted with a screw propeller, was launched into the Mersey. This vessel was constructed for Captain Stockton, of the American Navy, who has been already mentioned, and consequently received the name of the *Robert F. Stockton*. To the kindness of Mr. John Laird I am indebted for the drawing of this vessel, as she was rigged for her first voyage across the Atlantic; and from one of the scientific journals already quoted the following particulars are extracted. 1838.

"Several experiments have been made with her (the *Robert F. Stockton*), the results of which appear very satisfactory, both in relation to the application of the propellers to inland and to ocean navigation; and these experiments derive additional weight from the fact of their having been performed and approved of in Liverpool, the grand emporium of shipping and of commerce.

"Respecting the speed which it has been asserted may be attained by the new propeller, we have to notice a brief trial made below Blackwall on the 12th January, 1839, in the presence of about thirty gentlemen, many of whom were scientific and practical men. The result was, that a distance of nine miles (over the land) was passed in 35 minutes, with the tide; thus proving the speed through the water to be between 11 and 12 miles per hour. The propeller was only 6 feet 4 inches in diameter; the dimensions of the boat are given in the account of the next experiment. 1839. Jan. 12.

"An experiment, proving the great power of this propeller, with an account of which we have been supplied, was made on the 16th instant, between Southwark and Waterloo bridges, the result of which was as follows.

"Four coal barges, with upright sides and square ends, viz.

Nep. .	15 feet	beam,	drawing	4 feet 6 inches water.
Joseph,	15 feet 7 inches	do.	„	4 feet 6 inches do.
Mary, .	15 feet 2 inches	do.	„	4 feet 6 inches do.
Ugie, .	13 feet 4 inches	do.	„	4 feet 0 inches do.

1839. were made fast to the steamer, which is 70 feet long, 10 feet beam, drawing 6 feet 9 inches water,—one on each side, and each of these having one of the others behind it. Steam being set on, full speed was attained in about one minute, and the whole distance between the bridges, precisely one mile, was performed in eleven minutes, (being at the rate of 5·45 miles per hour),—the time chosen for the experiment being high water. The number of strokes made by the engines was 49 per minute. The cylinders, 16 inches diameter, with 18 inches stroke; the difference in the speed of the propellers being as 9 to 10: the outside one revolving at the greater speed, and being attached to the crank shaft directly, it follows that the inside propeller made only 44·1 revolutions per minute.

"Considering the square form of the barges towed, and that they presented together 59 feet 1 inch beam, with an average draught of 4 feet 4 inches, besides the sectional area of the steamer, which is 43 square feet; and considering also that the propeller is only 6 feet 4 inches diameter, occupying less than 2 feet 6 inches in length behind the stern of the boat,—the result we have now recorded may, in a mechanical point of view, be considered of great importance."

April, 1839. The *Robert F. Stockton* left England for the United States in the beginning of April, 1839, under the command of Captain Crane, of the American Merchant Service, a most intrepid sailor. His crew consisted of four men and a boy. Captain Crane made a forty days' passage, under sail only; and for his daring in thus crossing the Atlantic in this small vessel, he was presented with the freedom of the city of New York.

The machinery was so arranged that either one or two propellers might be used; and in the year 1838 she was worked with a single propeller in the River Thames.

In 1840, Captain Stockton sold this vessel to the Delaware and Rariton Canal Company, permission having first been obtained, by special Act of Congress, to run her in American waters, although of *English bottom*, her name being at the same time changed to that of

New Jersey. From that period to the present she has been in constant operation, as a steam-tug, on the Rivers Delaware and Schuylkill, with scarcely any cessation during the winter months, as she is capable of towing through the drift ice, when paddle-wheel steamers are of little use. 1839.

The *New Jersey* was the first screw-propelled vessel practically used in America, numerous experiments with the screw having been previously made without success. The value and importance of the screw as a propeller having been thus clearly demonstrated, one hundred and fifty other vessels have since been so fitted and propelled in America, most of which are now in active operation in the carrying trade, returning large profits to their owners, particularly those employed on the great North American Lakes.

As a further proof of the practical value of this invention, it may be mentioned that in the Spring of the present year (1848), 13 screw-propelled vessels were employed on Lake Ontario, and only 9 paddle-wheel steamers.

This remarkable instrument has completed the link of internal steam communication of the United States, by uniting Lake Ontario and the St. Lawrence with the immense upper lakes through the Welland Canal, and also the Chesapeak Bay and the southern waters with the River Delaware and the northern waters, through the Chesapeak and Delaware Canal.

It may also be mentioned, as an interesting historical fact, that the introduction of the first screw steamer, the *Ericsson*, between Philadelphia and Baltimore, by the *inland route*, via Chesapeak and Delaware Canal, completely annihilated, as a profitable speculation, one of the greatest works in the country, the Philadelphia and Baltimore Railway. To compete with this single vessel, built at an expense of a few thousand pounds, a Company which had expended millions was compelled to reduce its fares one-half! and the State of Delaware, through which the Canal passes, with a view of protecting

1839. the interests of the Company, imposed a prohibitory toll on passengers going by the screw propeller line. The freight business, however, was lost to the Company for ever.

Prior to Captain Ericsson leaving this country for America, he had built for Mr. John Thomas Woodhouse an iron screw propeller vessel, to run as a passenger boat on the Ashby de la Zouch Canal.

Aug. She was named the *Enterprize:* her length is about 70 feet, beam 7 feet, and her engines about 14 horses' power; her speed, where the water is wide and deep, is from 9 to 10 miles per hour. She was delivered and commenced to run on that canal in the middle of the month of August, 1839, and having run during a season without being profitable, she was then used as a steam-tug, on the Trent and Mersey, for a certain coal traffic, with great success. The introduction of railways has, however, rendered her valueless for that object, and she is now for sale.

It will thus be seen that Captain Ericsson accomplished for the screw propeller in America and in England, what Fulton did for the paddle-wheel in the former, and Bell in the latter country, namely, its practical introduction.

On the 29th July, 1839, an Act of Parliament was obtained, entitled "An act for forming and regulating a company to be called 'The Ship Propeller Company,' and to enable the said company to purchase certain letters patent."

This company subsequently purchased letters patent which had been granted to Francis Pettit Smith in England, on the 31st May, 1836, and being a numerous, wealthy, and influential body, they had an experimental steam screw vessel built of timber: this vessel was named the *Archimedes*, and made her first experimental trip on

Oct. 14. Monday, the 14th October, 1839. A second experimental trip was made on the following Wednesday, in presence of a number of distinguished naval officers and engineers. Among the numerous visitors on board were, Sir Edward Parry, Sir William Symonds, Colonel Acklom; Captains Basil Hall, Austin, and Smith, R. N.;

Messrs. D'Este, P. Ewart, C. E., — Miller, C. E., and — Manby, C. E., all of whom appeared to pay minute attention to the action of the machinery.* 1839.

"The *Archimedes* was fitted in the first instance with a single-threaded screw; but the velocity of the vessel was found not to be so great as with the double thread. It also communicated a vibratory movement by the angular resistance being transferred alternately from the leading end at the axis to the after part. This was totally obviated by the double thread.

"*Experiments.*—The first experiments were made with a view to determine the speed of the *Archimedes* in smooth water. For this purpose various trials were made at a point called 'the measured mile' in Long Reach, and her mean speed was ascertained to be 9·64 miles per hour. But as it was to sea-going vessels that the screw was at first considered to be peculiarly adapted, so soon as all was complete the vessel made several voyages, the results of which appear to have been highly satisfactory.

"An application being made to the Admiralty, it was ordered that a series of trials should be undertaken to and from Dover with her Majesty's steam packets belonging to that port; and Captain Chappell, R. N., was deputed to report thereon, and to institute such other experiments as he might deem necessary."†

Before Captain Chappell's arrival, however, several interesting trials were made, a log of which was kept by Captain Burridge, R. N. (who was on board the *Archimedes* during the trials). Captain Chappell subsequently sailed round England and Scotland in her, calling at numerous ports in his passage. An interesting and valuable account of the several experiments, will be found in the work here quoted.†

The successful performances of this vessel brought the screw into

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* "Inventor's Advocate," vol. i. p. 152.

† "Appendix D. to Tredgold on the Steam Engine." London: Weale, 1842.

1839. more general notice, and greatly extended its use. Her dimensions, &c. were as follow :—

Extreme length . . .	125 feet.
Length between perpendiculars .	106 feet 8 inches.
Extreme breadth . . .	21 feet 10 inches.
Depth of hold	13 feet.
Draft of water aft . . .	10 feet.
Draft of water forward . .	9 feet.
Burden	232 tons.
United power of engines . .	80 horses.

It does not appear that the *Archimedes* was ever employed as a trading vessel. After several experiments, she lay for a long time in the East India Dock, and was advertised for sale. Her spirited proprietors, who had been so instrumental in expediting the introduction of the screw propeller, and in thus conferring a public benefit, were minus a very large sum of money, not less, it is believed, than fifty thousand pounds.

1837. Sept. 20. Prior to the purchase of Mr. F. P. Smith's patents by the 'Ship Propeller Company,' he had experimented, in 1837, with the screw in a smaller vessel of about 6 tons burden, with a steam engine the cylinder of which was 6 inches diameter and 15 inches stroke. The results of these experiments were deemed satisfactory, and are given in the work last referred to.

Although some hundreds of patents have at different periods been granted for various kinds of instruments for the propulsion of vessels, it is a remarkable fact that the only two which have hitherto succeeded, and been brought into practical operation, are the paddle-wheel and the screw, each under various modifications. The action of a paddle wheel in the water resembles in some measure that of a pinion in a rack, while the motion of the screw may be compared with that of a screw in a nut. The water receding, however, from the action both of the wheel and the screw, renders it an imperfect

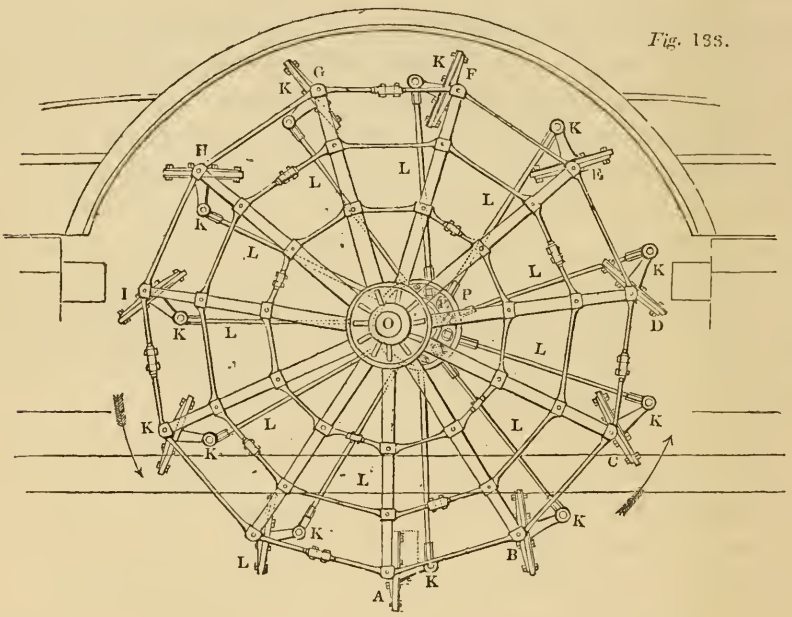
rack in the one case, and an imperfect nut in the other. The main object aimed at by the improvers of each instrument has been so to construct a wheel or a screw that the water shall be disturbed by its action in as slight a degree as possible, whereby the resistance to the engine is increased, and the progress of the vessel consequently improved. It may therefore be laid down as a general principle that whenever water is acted against to produce the progress of a vessel through it, whether by means of the wheel or screw, or by any other mechanical means, that method will generally be found the most efficient which disturbs the water the least at the place of reaction, and *vice versa*. 1837.

The paddle-wheel as improved by Mr. Patrick Miller, of Dalswinton, is that now in most general use, and the wheel since known by the name of Morgan's wheel, the patented invention of Mr. Elijah Galloway, is admitted to be the best improvement which has been made on Miller's wheel, the fastest sea-going steamers being fitted with it—namely, the *Banshee*, the *Victoria and Albert* (the Queen's yacht), and many other steam ships in the naval and civil service. Mr. Galloway's patent was obtained on the 2nd of July, 1829, and at the expiration of 14 years, as it had not remunerated the inventor, or the then owners of it, an extension for the further term of 5 years was granted. 1829. July 2.

" This paddle-wheel is represented in fig. 133. The contrivance may be shortly stated to consist in causing the wheel which bears the paddles to revolve on one centre, and the radial arms which move the paddles to revolve on another centre. Let A, B, C, D, E, F, G, H, I, K, L be the polygonal circumference of the paddle-wheel, formed of straight bars, securely connected together at the extremities of the spokes or radii of the wheel which turns on the shaft which is worked by the engine; the centre of this wheel being at O. So far this wheel is similar to the common paddle-wheel; but the paddle-boards are not, as in the common wheel, fixed at A, B, C, &c., so as to

1829. be always directed to the centre O, but are so placed that they are capable of turning on axles which are always horizontal, so that they can take any angle with respect to the water which may be given to them. From the centres, or the line joining the pivots on which these paddle-boards turn, there proceed short arms K, firmly fixed to the paddle-boards at an angle of about 120°. On a motion given to this arm K, it will therefore give a corresponding angular motion to the paddle-board, so as to make it turn on its pivots. At the extremities of the several arms marked K is a pin or pivot, to which the extremities of the radial arms L are severally attached, so that the angle

Fig. 138.



between each radial arm L and the short paddle-arm K is capable of being changed by any motion imparted to L: the radial arms are connected at the other end with a centre, round which they are capable of revolving.

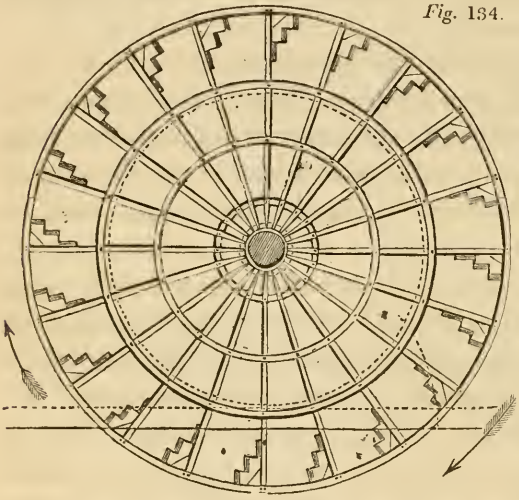
"Now, since the points A, B, C, &c., which are the pivots on which the paddle-boards turn, are moved in the circumference of a circle, of which the centre is O, they are always at the same distance from that point; consequently they will continually vary their distance from the other centre P. Thus, when a paddle-board arrives at that point of its revolution at which the centre round which it revolves lies precisely between it and the centre O, its distance from the former centre is less than in any other position. As it departs from that point, its distance from that centre gradually increases until it arrives at the opposite point of its revolution, where the centre O is exactly between it and the former centre; then the distance of the paddle-board from the former centre is greatest. 1829.

"This constant change of distance between each paddle-board and the centre P, is accommodated by the variation of the angle between the radial arm L and the short paddle-board arm K: as the paddle-board approaches the centre P, this gradually diminishes; and as the distance of the paddle-board increases, the angle is likewise augmented. This change in the magnitude of the angle, which thus accommodates the varying position of the paddle-board with respect to the centre P, will be observed in the figure. The paddle-board D is nearest to P; and it will be observed that the angle contained between L and K is there very acute: at E the angle between L and K increases, but is still acute; at G it increases to a right angle; at H it becomes obtuse; and at K, where it is most distant from the centre P, it becomes most obtuse. It again diminishes at K, and becomes a right angle between A and B. Now this continual shifting of the direction of the short arm K is necessarily accompanied by an equivalent change of position in the paddle-board to which it is attached; and the position of the second centre P is, or may be, so adjusted that this paddle-board, as it enters the water and emerges from it, shall be such as shall be most advantageous for propelling the vessel, and therefore attended with less of that vibration which arises chiefly

1829. from the alternate *depression and elevation of the water*, owing to the oblique action of the paddle-boards.

1833. "In the year 1833, Mr. Field constructed a paddle-wheel with fixed paddle-boards, each board being divided into several narrow slips arranged one a little behind the other, as represented in fig. 134. These divided boards he proposed to arrange in such cycloidal curves that they must *all enter the water at the same place* in immediate succession, avoiding the shock produced by the entrance of the common board.

Fig. 134.



"These split paddle-boards are as efficient in propelling when at the lowest point as the common paddle-boards, and when they emerge *the water escapes* simultaneously from each narrow board, *and is not thrown up*, as is the case with common paddle-boards."*

A large number of vessels are fitted with this form of wheel; the *Great Western* is among the number.

The unfortunate steam ship the *President* had a pair of such wheels during some of her voyages; but her proprietors, rather than pay the required patent right, had them removed, and replaced by the common wheels.

This circumstance is not mentioned invidiously, but as a matter of history. It is not supposed that the change of wheels had the slightest connection with the loss of the ship.

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* "A patent was subsequently obtained for these by Mr. Elijah Galloway on the 18th August, 1835. Mr. Field did not persevere in its use at the time he invented it."—Dr. Lardner on Steam Engine, Steam Navigation, and Railways. London, 1840.

The specification and other particulars in connection with this patent may be found in several scientific journals.* Many modifications of the paddle-wheel have been patented, and experimentally tested; but it may be said that the three last described inventions only are now generally in use.

Various patents have also been granted, at different periods, for another instrument for propelling vessels, commonly denominated ' The Screw Propeller.'

One form of the instrument is that of a blade, or blades, cut from a plane, and placed at an angle on an axis, similar to the blades of a smoke-jack, as ordinarily made.

A second form is that in which the blades resemble those of a truly formed screw of one or two turns in length, or sections of a screw of less than one turn in length; the latter being similar to those patented by Captain Ericsson in 1836, and shown in the drawing of the machinery fitted in the *Robert F. Stockton*, which was built so that either one or two of such propellers could be applied.

The third form differs essentially from either a plane or a screw, the blade being made to vary in its angle from the axis throughout the whole length of such propeller, no section of it, however short, having upon it either a plane surface or the surface of a screw.

This last form of propeller is known by the name of " the increasing pitch screw propeller," although, as before stated, it differs essentially in form from that of a screw. It is the only propelling instrument of any description which has the peculiar and inherent property of acting with an increased impulse against the water from the leading part, first taking its action against the water to the end, however long or short such propeller may be upon its axis.

This instrument, the invention of the author of this Sketch, was patented on the 22nd of March, 1832, under the title of " Certain 1832. March 22.

* See the " Repertory of Arts," vol. v. (new series) p. 290; the " London Journal," vol. viii. (conjoined series) p. 55; and the " Mechanic's Magazine," vol. xxiv. p. 241.

1832. improvements in the construction and adaptation of a revolving Spiral Paddle for Propelling Boats and other Vessels on Water."

This invention having given results superior to those of any other form of submerged propeller, when tried under similar circumstances, and having been extensively adopted in vessels employed in the merchant service, the author is induced to insert the following description, extracted from the Specification of the Patent.

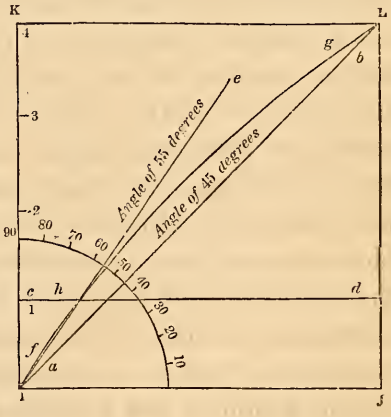
"My said invention consists in a *spiral paddle*, made of wood, metal, or any other suitable material, of the following construction, by the revolution of which boats or other vessels may be propelled on water: that is to say, a spiral worm, blade, or screw coiled round a shaft or cylinder *of any convenient length and diameter*, in such form that the angle of inclination which the worm makes with the axis of the cylinder continually decreases, and the pitch or distance between the coils or revolutions of the spiral continually increases throughout the whole length of the shaft or cylinder upon which the spiral is formed, the effect of which construction is as follows:—The spiral paddle being made to rotate in the water, when the commencement of the spiral blade, or that part of it which forms the greatest angle with the shaft, acts upon the water, it gives to it an impetus or motion towards the back end of the paddle, thus creating a current in the direction of the spiral. If this current were to reach the succeeding or following parts of the spiral paddle before those parts take their action upon the water, such following parts would move in, or keep pace only with, the current, and would therefore meet little or no resistance from the receding water, and a part, or the whole, of their action would be lost or without effect. But by progressively elongating the pitch of the spiral, *each successive part* of the spiral begins to act before it is overtaken by the current given to the water by the action of the preceding part of the spiral, and consequently *every part* meets resistance from the water, and thereby gains a portion of propelling power.

"The spiral paddles being thus made to rotate in contact with the

water, the spiral paddles and the water act together on the principle of the nut and screw, the water being the nut, and the spiral paddle the screw, and the vessel thus receives a progressive motion through the water. The ratio of motion thus obtained will depend upon the speed at which the spiral paddles are made to rotate upon their axles, and the power of propelling upon the *diameter and length of the spiral paddle*, together with the ratio or degree of the increasing inclination of the spiral blades towards the axles of the paddles. 1832.

"The spiral paddles may also be placed *under the stern of the vessel* instead of at the sides, as seen in fig. 5 and fig. 6, where a part of the hull is removed, and the paddles marked G, H, I, J, in fig. 6, are introduced into the space, and are firmly fixed to the boat, and connected with the steam engine by suitable intervening machinery; a protection is also by these means afforded to the paddles without augmenting the width of the vessel.

"The manner in which I describe *a spiral blade* varying in its pitch or inclination to the axis of the paddle in such ratio or degree as I consider best adapted for the said purpose of propelling vessels is as follows:—viz. let I, J be a right line *equal to the direct length of the spiral part of the paddle required*, and on I, J describe the square I, J, K, L; draw a diagonal from the angle I to the opposite angle L, which line will form an angle with the line I, J of forty-five degrees; then divide the side I, K of the square into four equal parts, as at 1, 2, 3, 4, and through the point 1, of these divisions, draw the line *c*, *d* parallel to the line I, J.



From the angle I of the square draw the line I, *e* at an angle of fifty-five degrees with the line I, J, and where the line I, *e* intersects the horizontal line *c*, *d*, at the point *h*, it gives a point through

1832. which the segment of a circle, *f, g*, must be drawn from the angle I to the angle L of the square I, J, K, L. If then the paper or other medium upon which *this segment of a circle, f, g*, is drawn, *be transferred to* or rolled on a cylinder, *the radius of which is equal to the radius of the spiral worm, the segment of a circle, f, g, will describe upon the surface of such cylinder the outer circumference of the spiral worm required.* And I declare that although I consider a spiral blade so produced as aforesaid the best adapted for a paddle for the said purpose of propelling boats or other vessels on water, I do not confine myself to the aforesaid or to any particular ratio or degree of increasing pitch or inclination in the spiral blade of my said paddle. And I claim as of my invention, the construction and adaptation for the purpose aforesaid of a spiral paddle in which the pitch or inclination of the spiral blade to the axis of the paddle continually increases, whatever be the ratio or degree of such increase. And I further declare, that although I have hereinbefore described several combinations of my said improved paddles, in order to illustrate the use and employment thereof for the said purpose of propelling boats or other vessels on water, yet I do not confine myself to any particular arrangement or combination of my said paddles in the employment thereof for the aforesaid purpose; nor do I confine myself to any particular number of paddles to be so employed, inasmuch as my said improved paddles may be employed for the purpose aforesaid in various arrangements and combinations, *and either singly* or in combinations of two or more."

1832. July. In the month of July, 1832, a public trial was made with this invention on a boat of 55 tons burden, on the river Irwell, near Manchester. The boat was the property of the New Quay Company in that town: she was 14 feet broad in the bow, and had a draught of water, at the time, of between two and three feet. She was propelled by two copper screws of greatly increasing pitch, one on each side,—the one a right-handed, the other a left-handed screw. The screws were each about two feet in diameter, and being turned by a number of men, the boat attained a speed of 4 miles an hour.

In April, 1834, plans of this invention, as applicable to ships of war, were presented to the Lords Commissioners of the Admiralty, by Joseph Brotherton, Esq., M.P. 1834.

In the year 1841 a series of experiments was made in the British Channel, for the purpose of testing the powers of the author's screw, (the blades of which were of increasing pitch,) and those of other screws, the blades of which were inclined planes, or screws, properly so called. The vessel in which these experiments were made was the *Archimedes*, and they were conducted under the superintendence of Mr. T. R. Guppy, C.E. 1841.

The following Table, extracted from the "Practical Mechanic and Engineers' Magazine" of the 25th October, 1845, gives the results of the several experiments, and the performances of the screws employed. 1845.

Number of Experiment.	Strokes of Engine per minute.	Horse-power by indicator.	Speed of Vessel in Knots.	Speed of Screw in Knots.	Ratio of Speed of Vessel to that of Screw.		Diameter of Screw.		Pitch.	
							Ft.	In.	Ft.	In.
1	25·41	67·1	8·375	10·646	·787	Smith's two half-threads, made of wrought iron	5	9	8	0
2	20·75	53·7	8·16	10·88	·75	Ditto ditto ditto . . .	5	9	10	0
3	26·25	63·69	7·55	8·23	·917	Ditto ditto, made of cast iron	7	0	6	0
4	20·5	57·13	7·42	8·52	·87	Ditto ditto ditto . . .	7	0	8	0
5	20·0	57·3	8·175	8·0	1·02	Woodcroft's increasing pitch, 3 blades, made of cast iron, and as first constructed . .	7	0	7	$7\frac{1}{2}$
6	21·5	62·6	8·1	8·1	1·0	The same, with 3 inches cut off the termination of the blades	7	0	7	$2\frac{1}{2}$
7	22·5	62·12	8·273	8·73	·94	The same, with 4 inches cut off the entering edges of the blades	7	0	7	5
8	20·5	51·4	8·566			Four wrought iron arms, with blades, each 2 feet 9 inches long by 1 foot broad . .	7	0	8	0

In a Paper read before the Institution of Civil Engineers, by Mr. Guppy, entitled "A Description of the *Great Britain* iron steam

1845. ship, with the screw propeller, and an account of the Trial Voyages," the following remarks on the above experiments occur, relative to the screw with increasing pitch:—

"Particular attention is due to the experiments No. 5, 6, and 7. Reasoning upon the assumption, that the effort of the entering edge of each blade must cause the water to recede, and that each succeeding portion of the blade should so increase in pitch as to impinge with uniform force against the water which was so receding, a screw of this description was made and tried. The first trial served to show that the curvature or increase of pitch which had been given to it was too great, since the speed of the vessel was greater by 2 per cent. than that due to the mean pitch of the screw; whence it was evident that the entering edge was really retarding, and the terminating portion alone was doing the duty. On the second trial, when a radial strip, three inches in width, had been cut off the after part of each blade, the speed of the vessel was exactly that due to the screw; whence it was also evident that the front edge did not assist.

"On the third trial, after a second radial slip of four inches had been cut off the entering edge of each blade, the vessel attained a speed of 8·2 knots, and the ratio of speed of vessel was as ·94 to 1 of the screw.

"The horse-power employed on this trial was, by indicator, 62·12, and the speed of the vessel 8·2 knots, against 67·1 horse-power, in the before-named trial, with the original screw of the *Archimedes*, when the speed she attained was 8·375 knots."

The increasing pitch screw, which had been experimentally tried in the *Archimedes*, was subsequently put to work in the *Napoleon* French Post Office Steamer, built by M. Normand, of Hâvre.

1843. In May, 1843, the Lords Commissioners of the Admiralty directed the author to make a screw *at his own cost*, which they would "cause to be tried on the *Rattler*." This screw was made of copper, having four blades; and it corresponded in every respect with a screw of uniform pitch, also made of copper, in the number of its blades, its diameter, length, and pitch, with this exception, that although they

each commenced with the same pitch, the author's screw gradually increased in its pitch throughout, and terminated with an increase of five per cent. additional pitch.

The trial of Smith's 4-bladed Archimedian or true screw took place in the *Rattler* on the 18th March, 1844; and on the 13th April in the same year, a trial of the author's increasing pitch screw, of four blades, was made with the same vessel. After this latter trial, Mr. Lloyd, the chief engineer of the Admiralty, who had been present to superintend it, stated to the author, who had also been present, that the latter screw was superior to the uniform pitch screw in two important qualities; first, that it propelled the vessel at an equal speed with less power; and secondly, that it also propelled the vessel at an equal speed with fewer revolutions of the screw, which latter quality he considered superior to the former; but that the difficulty arising from having to drive screws so fast, constituted the greatest obstacle to their introduction in the Royal Navy. 1844.

The results of these trials were as follow:—

1844.		Horses' Power exerted.	Strokes of Engine per minute.	Revolutions of Screw per minute.	Knots run per hour.
18th March	Smith's uniform pitch screw . . .	459·	26·28	104·34	8·18
13th April	Woodcroft's increasing pitch ditto .	428·76	24·152	95·99	8·159
	Results in favour of Woodcroft's screw		2·128	8·35	·921
	Ditto ditto of Smith's screw .				

This screw was subsequently returned to the patentee, and sold as old metal.

The comparative merits of this screw were stated by Mr. Murray, Assistant Engineer to the Admiralty, when examined on oath before the Judicial Committee of the Privy Council, to be, that "the result exhibited in Mr. Woodcroft's favour was a speed nearly as great with much less power of the engines, with less 'slip'; and if the facts, as

stated, were reduced to a common measure, it would give one-sixth of a knot per hour in favour of Mr. Woodcroft's propeller."

1845. In the early part of the year 1845, the author obtained an order from the Lords Commissioners of the Admiralty for another screw of increasing pitch, to be used in the *Rattler*, which was made and sent to that vessel, and subsequently paid for by the Admiralty.

1846. The comparative merits of this second screw were thus stated by Captain Henry Smith, R. N., the Commander of the *Rattler*, in evidence before the Judicial Committee of the Privy Council, from a memorandum he had made at the time: "I think Mr. Woodcroft's spiral propeller superior to any yet tried in the *Rattler*. It has less vibration, less fuel is consumed, with fewer revolutions and greater speed; consequently, there is less 'slip.' On the 25th February, 1846, the result of going with a head-wind blowing hard, was better than any before."

And on the same occasion Mr. Langlands, the Chief Engineer of this vessel, stated "that this screw gave greater speed, with fewer revolutions, less vibration, and used up the power of the engine better."

1846. This patent expired in March, 1846, without having produced any profit to the patentee, or any remuneration for the loss of his time. An extension of the term of the patent was applied for, and granted for six years, although such application was opposed by the 'Ship Propeller Company.'

The members of the Judicial Committee present on that occasion were the Duke of Buccleuch (Lord President), Lord Brougham, and Dr. Lushington; and the following is extracted from the Judgment delivered by Lord Brougham:—

"Then as to the merits of the invention.—In this case there appears to be no doubt whatever. The evidence of all the scientific men, and of all the practical men, who have been examined before their Lordships, appears to prove that it is an invention, we should say, as far as it appears before us, original, and also, as far as it appears before us, of very considerable merit and value. We cannot

here weigh degrees of merit in golden scales. If there is considerable merit, with originality, and some considerable usefulness to the public, that suffices. 1846.

"Then it is said that this rests upon opinion. No; Mr. Carpmael speaks to opinion, and Mr. Cowper speaks to opinion, both of them respectable witnesses, and unimpeachable by any contrary testimony; unimpeached, also, by their being at all shaken upon a very strict cross-examination. But those are not the only witnesses, because we have a practical man in Mr. Slaughter (an engineer and ship-builder at Bristol), who states that he built three vessels, two of them of 127 tons each, (according to my recollection of the evidence,) and one of 138 tons, and that those vessels answered perfectly, and gave satisfaction. The two first have been constantly tried, I think he said for six months, and they are daily seen in operation, and with perfect success. Mr. Grantham had since taken out licenses for a considerable number of other vessels under the present patent, and from the patentee.

"We have the evidence likewise of the gentleman who saw the *Avon* at Bristol: and we have the evidence, and very material evidence it is,—of Captain Henry Smith, and of Mr. Andrew Murray: Captain Smith saw the *Rattler* tried with this 'spiral,' and gave a strong and unhesitating testimony in favour of its operation in the sailing of that ship. Captain Smith's evidence was general, but it was from his own practical and direct experience of the vessel. Mr. Andrew Murray's was more specific. He is a civil engineer at the Admiralty, and he, under several heads, through which I need not go, instituted a comparison in the months of March and of April, 1844, respectively. Mr. F. P. Smith's he tried in the month of March, and Mr. Woodcroft's in the month of April, 1844; and he produced, to refresh his recollection, the memoranda or notes which he took of the working of the vessel at the time of making those experiments upon the two several principles. This testimony is decisively in favour of Mr. Woodcroft's patent. Mr. F. P. Smith's is a

1846. very ingenious invention, I make no manner of doubt; it is a considerable improvement upon former inventions; and yet, upon that improved invention being compared with Mr. Woodcroft's, the latter is found, in every particular in which it is tested by this trial, to have the advantage. I think the result of the whole was, that with less horse-power, (in the one case there being twenty-four horse-power and a fraction, and twenty-six horse-power and a fraction in the other,) making about one-twelfth part less power, nevertheless reducing the 'slip,' and, getting at one figure, the proportion of improvement of the one over the other, it amounted, I think, to one-sixth of a knot an hour. Upon the whole, therefore, this is very satisfactory evidence as to the real practical use of the improvement.

"Now, we always take into account, independently of the evidence, the nature of the invention. It appears to my mind that there is a clear step made in the progress of steam navigation, and in the construction of that very useful implement in steam navigation, the 'screw' for the purpose of propulsion. The step made is, as to the increase of velocity of the parts of the propeller, and its overtaking the wave and not coming to be of equal velocity with the wave; and that is accomplished by a very refined and ingenious contrivance; and, speaking as a scientific man merely, an original one. I mean substituting for a rectilinear screw wound round the cylinder, a curvilinear screw wound round the cylinder. I am of opinion, speaking upon scientific principles, that these are ingenious and important novelties in this matter. It is introducing a new mathematical principle as well as a new mechanical principle, and I hold it to be a highly important improvement. However, it is enough to go with the evidence, and upon the evidence before us, both of scientific men giving their opinions, and of practical men speaking to matters of fact, according to their own experience, this is a great practical improvement."

It is a singular circumstance, that the only increasing pitch screw in the Royal Navy is the one made by the author for the *Rattler*, although its merits have so long been known and admitted by the chief engi-

neer; and it is still more remarkable, that although a large number of screws of uniform pitch have subsequently been made for trials, the author is not aware that a single screw of an increasing pitch has been made for the same object, with one exception, a notice of which appeared in the following statement, extracted from the *Times* of 5th July, 1848. 1846.

"Woolwich, July 5.—The *Minx* steam-vessel, one hundred horse-power, went down the river last week, with thirteen different modifications of screw propellers, for which she is fitted, one shipped, and the others to be tested, to ascertain their relative qualities in giving speed to the vessel. Mr. Trickett, first assistant inspector of steam machinery at Woolwich Dockyard, attended on board to test the various screw propellers, and the whole thirteen were tried with the greatest care, as many as thirty passages being made in one day up and down the measured mile at Long Reach, commencing the trials at four o'clock in the morning, and continuing them until dusk on Thursday, Friday, and Saturday last. The result of the repeated trials was in favour of a form of screw propeller submitted by Mr. Woodcroft, and slightly altered on the suggestion of Mr. Atherton, chief engineer and inspector of steam machinery at Woolwich Dockyard, Woodcroft's screw having propelled the *Minx* at the rate of nine knots per hour, and when at its greatest velocity the engines performed about three revolutions per minute more than with any of the other screws."*

It has recently been intimated to the author, that by some persons an increasing pitch screw has been deemed objectionable on the ground of its incapability to move a vessel backwards so well as a screw of the common or uniform pitch: the fact that the back of this screw can also be made to increase in its pitch must therefore have been wholly overlooked by those who entertain such an opinion.

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* For the Specification of this Patent the reader is referred to the "Repertory of Arts," vol. vii. (enlarged series) p. 293; "London Journal," vol. i. (conjoined series) p. 349; "Register of Arts," vol. vii. (new series) p. 295.

844. On the 13th February, 1844, the author obtained a patent for
eb. 13. "his invention of varying at pleasure the Angle of Screw Propeller Blades with the axis on which they work, according to the varying circumstances of wind, current, tonnage, and the other conditions affecting the action of the motive power in Vessels."

A model of this invention was submitted to the notice of the Lords of the Admiralty, who subsequently ordered a propeller to be made on the improved principle for H. M. S. *Dwarf*. This order was executed by Mr. Whitworth, of Manchester, and the screw was sent to Woolwich on the 26th September, 1846. It has not yet been tried, and therefore its qualities remain unknown; but as it is different in its construction and mode of action from any other screw propeller, a brief description and a drawing of it may be interesting.

The material of which it is made is gun-metal: in diameter it is 5 feet 8 inches: The two blades may be altered in their angle to the axis so that the pitch will range from $4\frac{3}{4}$ feet to $10\frac{3}{4}$ feet.

As the shaft upon which the screw is fixed in the *Dwarf* is made by the engines to revolve 165 times a minute when the blades are placed at the pitch of $4\frac{3}{4}$ feet, provided there is no recession of the water, the vessel would be driven through the water at the rate of $8\frac{3}{4}$ miles and 274 yards per hour; and if the blades were placed at the pitch of $10\frac{3}{4}$ feet, and the screw driven 165 turns per minute, the Vessel would (assuming no recession of the water) then be propelled at the rate of 20 miles and 274 yards an hour.

The chief object in causing the blades of the screw to vary in their angle, as before described, may be thus stated. If the engines were made to drive the screw through the water at the rate of ten miles an hour, and the vessel got on a wind which alone would drive her at twelve miles an hour, the engines would increase their speed, but their power would be wasted; and the screw, although revolving, would thus become an impediment to the progress of the ship. If, however, the pitch of the screw were altered to a speed greater than that at which the vessel was sailing by the wind, the whole power of the engines might be applied, in addition to the wind, to aid in the

propulsion of the ship; and if she had then to go against a head-wind, such wind would be an impediment to her progress, and the course (or fast) pitch of the screw would prevent the engines from making the full number of strokes per minute, and consequently a portion of their power would be lost; so that if the pitch of the screw were reduced to the degree which allowed the engines to make their full number of strokes per minute, they would then, on the contrary, be exerting their full power.

The object, therefore, of this screw, is to enable the engines to give out their full effect under all the varying circumstances of wind, current, tonnage, and the other conditions which affect the progress of a vessel through the water. It might also be made to act upon the engines by intermediate machinery, and thus to regulate their speed under the circumstances already mentioned, by the aid of governors, such as are usually employed to controul the speed of Stationary Steam Engines.

It is an extraordinary circumstance, that this screw, which has been in the store-house at Woolwich for a period of more than two years, has not yet been tried, particularly as the *Dwarf*, for which it was made, lay in the adjoining dock out of use for a long period of time after its arrival: but this circumstance appears still more extraordinary when it is considered that this single screw is capable of giving as many different results as were obtained from the whole of the screws subsequently made and tried in *Minx*, with almost an infinity more, and each with greater correctness, the screw for *Dwarf* having been made with the utmost mechanical accuracy, whilst the others had less trouble bestowed upon them.

The reason assigned for the delay is, that no dry dock in the yard can be spared for the *Dwarf* to have her screw fitted. 1848.

*** For the specification and drawings of this last mentioned patent the reader is referred to the "Repertory of Arts," vol. iv. (enlarged series) p. 277; the "London Journal," vol. xxvii. (conjoined series) p. 346; and the "Engineer and Architect's Journal," vol. vii. p. 322.

LIST OF PATENTS,

Nearly all of which are for Propelling Vessels, and other Documents relating to Propelling, which the Author has prepared for Publication.

1618, Jan. 17th. [9] David Rumsey and Thomas Wildgoose.

1627, Jan. 3rd. [40] Arnold Spencer.

1630, Jan. 21st. [53] David Rumsey, Esq.

1632, July 20th. [59] Thomas Grent, Doctor of Physick.

1634, June. [68] Arnold Rotispen.

1637, Sept. [106] Francis Lin, Henry Yorke, and Francis Myles.

1640, March. [126] Edward Ford, Esq.

1661, Feb. 8th. [131] Right Honourable Edward, Marquess of Worcester.

1661, May 16th. [132] Thomas Toogood and James Hayes, Esq.

1675, Aug. [139] Thomas Toogood and James Hayes, Esq.

1675, Feb. 17th. [157] Peter Chamberlain, Doctor in Physick.

1692, Feb. 22nd. [294] Anthony Duvivion, Esq.

1693, March 3rd. [313] John Hadley, Engineer.

1694, Sept. 29. [333] Colonel Jacob Richards.

1696, Jan. 10. [345] Thomas Savery, Gentleman.

1706, June 6th. [376] Robert Aldersey.

1724, Feb. 26th. [461] John Dickens.

1724, May 20th. [466] Richard Dunning, of Sampford Courtney, in the County of Devon, Esq.

1724, Nov. 4th. [470] Robert Bumpstead, Gent.

1725, Feb. 11th. [473] Thomas Smith, Esq.

1729, Aug. 7th. [511] John Allen, Doctor in Physick.

1731, Oct. 18th. [532] George Reynoldson, of Saint Helen's, in the City of York, Upholsterer.

1736, Dec. 21st. [554] Jonathan Hulls.

1737. A Description and Draught of a new invented machine, London, 1737.

1760. Some new enquiries tending to the improvement of Navigation, J. A. Genevois. London, 1760.

1760, Nov. 27th. [753] Francis Xavier de Arles de Liniere, of Suffolk Street, St. Martin's-in-the-Fields, Westminster.

1763, March 3rd. [783] Charles Burne, of Sunderland, in the County of Durham, Coal-fitter.

1766, Dec. 17th. [864] Isaac Levy, of the City of London, Merchant.

1767, Nov. 11th. [882] Stephen, Baron de Bissey, of Princes Street, Leicester Fields, Middlesex, Gentleman.

1769, March 14th. [918] Francis Moore, of Cheapside, London, Linen Draper and Warehouseman.

1769, June 19th. [928] Francis Moore, of Cheapside, London, Linen Draper and Warehouseman.

1769, July 13th. [931] Francis Moore, of Cheapside, London, Linen Draper and Warehouseman.

1775, Nov. 22nd. [1106] Samuel Miller, of Southampton, Sail-maker.

1776. Description of a Submarine Vessel or Torpedo, for blowing up ships, invented by M. D. Bushnell.

1776, March 11th. [1115] Michael Lawrence-Berford, son of Launcelot Berford, late of Lisbon, in the kingdom of Portugal, but now of the Middle Temple, London, Esq.

1776, Sept. 9th. [1130] James Guerimand, of St. Giles, Middlesex, Watch-maker.

1779, March 10th. [1210] Matthew Wasborough, of the City of Bristol, Engineer.

1780, May 4th. [1252] William Bache, of Birmingham, Chymist.

1784. April 10th. [1422] Wolfgang de Kempelen, of St. James's, Middlesex, Esq.

1784, Aug. 20th. [1442] Sutton Thomas Wood, of the City of Oxford, Brewer.

1785, May 9th. [1474] Joseph Bramah, of Piccadilly, Middlesex, Engine-maker.

1785, Nov. 2nd. [1498] Lionel Lukin, of Long Acre, Middlesex, Coach-maker.

1787, June 5th. [1606] William Symington, of Wanlockhead, in the Parish of Sanguahar, Dumfries, North Britain.

1788, March 4th. [1636] Robert Fourness, of Elland, in the Parish of Halifax, York, and James Ashworth, of the same place, Gentleman.

1788, Nov. 6th. [1669] James Rumsey.

1789, Dec. 12th. [1714] John Lewis de Lolme, of Saint Andrew, Holborn, Doctor of Civil Law.

1790, March 13th. [1729] Charles, Earl of Stanhope.

1790, March 24th. [1734] James Rumsey, of Saint Margaret, Westminster, Engineer.

1790, Aug. 17th. [1767] Charles, Earl of Stanhope.

1791, Feb. 10th. [1788] Isaac Manwaring, of Rosoman Street, Clerkenwell, Middlesex, Saw-maker.

1791, Oct. 31st. [1829] John Barber, of Warwick, Engineer.

1793. Mr. John Smith, of St. Helen's, Lancashire, claimant to be the inventor of Steam Navigation.

1794, July 15th. [1996] William Lyttleton, of Mansell Street, Goodman's Fields, Middlesex, Merchant.

1794, July 16th. [1997] William Fitzgerald, London.

1796. Description of a new-invented Fire-Ship that will conduct herself to any point and explode.

1796, May 3rd. [2102] Patrick Miller, of Dalswinton, North Britain, Esq.

1796, July 20th. [2127] Thomas Potts, of Sanctuary, Penrice, Glamorganshire.

1797, Oct. 31st. [2193] John Harriott, of Prescott Street, Goodman's Fields, Middlesex, Esq.

1797, Oct. 31st. [2196] Robert Beatson, of Kilvie, Fife, Esq., late of the corps of Royal Engineers.

1798, July 14th. [2245] John Dickson, of Dockhead, Surrey, Engineer.

1798, Aug. 23rd. [2256] George Dodgson, of Saint Leonard, Shoreditch, Middlesex, Cabinet-maker.

1798. Extract from the Life, Writings, and Mechanical Inventions of Edmund Cartwright on Screw-propeller.

1798, Nov. 27th. [2270] Mark Noble, of Royal Row, Lambeth, Surrey, Engine-maker.

1799, Jan. 5th. [2282] John Kent, of the Town of Southampton, Architect and Builder.

1799, Oct. 3rd. [2342] John Hotchkis, Esquire, Lieutenant in the Royal Navy.

1800, Feb. 1st. [2367] Edward Shorter, of Newington, Surrey, Mechanic.

1800, March 19th. [2376] Edward Steers, of the Inner Temple, London, Esq.

1800, March 19th. [2378] William Johnson, of Widmere House, Bromley, Kent, Esq.

1800, June 10th. [2407] William Johnson, of Widmere House, Bromley, Kent, Esq.

1800, Aug. 2nd. [2427] George Medhurst, of Battle Bridge, Clerkenwell, Middlesex, Engineer.

1801, July 31st. [2526] Mark Brown, late of New Town, Ireland, but now of Cooper's Row, Tower Hill, London.

1801, Aug. 20th. [2531] William Parkes, of Newington Butts, Surrey, Professor of Philosophy.

1801, Oct. 5th. [2537] James Tremeere, of Lamb's Conduit Passage, Saint George the Martyr, Middlesex, Carpenter.

1801, Oct. 14th. [2540] William Symington, of Kinnoird, Sterling, North Britain, Engineer.

1802, Jan. 28th. [2572] James Sharples, of the City of Bath, Gentleman.

1802, Feb. 19th. [2577] Henry Penneck and Robert Dunkin, of Penzance, Cornwall, Gentleman.

1801, Nov. 28th. [2556] Joseph Bramah, of Pimlico, Middlesex, Engineer.

1802, March 24th. [2595] Richard Trevithick and Andrew Vivian, of Cambourne, Cornwall, Engineers and Miners.

1802. An Account of Symington's new Steam-boat—Journal of the Royal Institution of Great Britain.

1802, Nov. 13th. [2655] Simon Huguenin, of Brook Street, Holborn, Middlesex, Engineer.

1803, Jan. 29th. [2672] George Matcham, of the City of Bath, Esq.

1803, March 16th. [2685] Samuel Miller, of Saint Pancras, Middlesex, Engineer.

1803, July 28th. [2720] John Norton, of Rolls Buildings, Fetter Lane, London.

1805, Nov. 23rd. [2893] Richard Lambert, of Wick Rissington, Gloucester, Gentleman.

1805, Jan. 16th. [2803] Edward Shorter, of New Crane, Wapping, Middlesex, Mechanic.

1805. Account of the Pamona, a machine moved by the wind, to be used on board ships.

1806, Feb. 20th. [2906] Thomas Kentish, of Baker Street North, Saint Marylebone, Middlesex, Engineer.

1806. Published Description of a Screw to propel Ships.

1806. On the means of impelling Ships without wind, by Screw.

1806, July 4th. [2943] John Curr, of Sheffield, York.

1807, April 9th. [3007] Charles, Earl of Stanhope.

1807, March 20th. [3018] John Day, of Camberwell Green, Lambeth, Surrey, Stone Mason.

1808, July 5th. [3144] Richard Trevithick, of Rotherhithe, Surrey, Engineer, and Robert Dickenson, of Great Queen Street, Middlesex, Esq.

1808, July 14th. [3148] James Linaker, of our Dock Yard, Portsmouth, Master Millwright.

1808, July 30th. [3153] John Curr, of Bell Vue House, Sheffield, York, Gentleman.

1808. On impelling Ships by compressed air.

1809, Feb. 11. Robert Fulton, specification and drawings of his first patent in America.

1809, March 20th. [3214] Simeon Thompson, of Maddox Street, Hanover Square, Middlesex, Gentleman.

1809, Oct. 28th. [3227] Richard Trevithick, of Rotherhithe, Surrey, Engineer, and Robert Dickenson, of Great Queen Street, Middlesex, Esq.

1810, June 19th. [3347] John Lindsay (late Lieutenant-Colonel of the 71st Regiment), of Grove House, Middlesex.

1810, Oct. 2nd. Robert Fulton, specification of his second patent in America.

1811, March 26th. [3419] John Ross, of Folkestone, Kent, a Lieutenant in the Navy; and Thomas Chapman, of Gough Square, London, Gentleman.

1811, March 26. [3422] Henry James, of Birmingham.

1811, May 1st. [3437] Stedman Adams, of Connecticut, one of the United States, now residing in London, Esq.

1811, July 19th. [3461] John Trotter, of Soho Square, Middlesex, Esq.

1812, May 9th. [3560] Henry Higginson, of Wilson Street, St. Luke's, Middlesex, Esq.

1812, Aug. 5th. [3587] John Rapson, of Penryn, Cornwall, Millwright.

1812, Dec. 19th. [3624] John Morgan, of York Street, Dublin, Doctor of Medicine.

1813, March 23rd. [3666] Colonel William Congreve, of Cecil Street, Middlesex.

1813, May 22nd. [3696] William Brunton, of Butterley Iron Works, Pentrick, Derby, Engineer.

1813, May 31st. [3698] Charles Brodrip, of Great Portland Street, Marylebone, Middlesex, Gentleman.

1813, Oct. 18th. [3737] Robertson Buchanan, of the City of Glasgow, Civil Engineer.

1814, July 26th. [3817] George Dunnage, of the Upper Mall, Hammersmith, Middlesex, Esq.

1814, July 26th. [3821] William Doncaster, of Charles Street, Cavendish Square, Middlesex, Gentleman.

1814, Aug. 4th. [3826] Tobias Mitchell, of Upper Thames Street, London, Gentleman.

1815. Description of a vertical Wind-mill to propel Ships.

1815, April 25th. [3903] Samuel Pauley, of Charing Cross, Middlesex, Civil Engineer, and Durs Egg, of the Strand, Gun Manufacturer.

1815, June 14th. [3921] William Pope, of Saint Augustus Place, Bristol, Perfumer.

1815, June 6th. [3916] Richard Trevithick, of Cambourne, Cornwall, Esq.

1815, June 22nd. [3926] Robert Dickenson, of Great Queen Street, Lincoln's-Inn-Fields, Middlesex, Gentleman.

1815, Dec. 19th. [3963] Robert Kinder, of Hill Street, Liverpool, Gentleman.

1816, Feb. 1st. [3972] John Millington, of Duke Street, Manchester Square, Middlesex, Engineer.

1816. Henry Bell's Letter to the Editor of the Caledonian Mercury.

1816, March 14th. [3990] James Davison, Esq.

1816, March 23rd. [4000] James Merryweather, of the Castle of Lincoln, Lincoln, Gentleman.

1816, Nov. 1st. [4065] Benjamin Smythe, of Liverpool, Schoolmaster.

1816, Dec. 10th. [4082] Richard Wright, of Bishopgate within, London.

1817, Oct. 10th. [4163] John Oldham, of South Cumberland Street, Dublin, Esq.

1817. Copious extracts from the Life of Robert Fulton, by his friend Cadwallader D. Colden, New York, 1817.

1817, Nov. 1st. [4166] Francis Marcellin Molle, of Bucklersbury, London, Merchant.

1817, Nov. 25th. [4173] Joseph Claude Niepee, of Frith Street, Soho Square, Middlesex, Esq.

1818, Jan. 23rd. [4203] John Scott, of Penge Place, Surrey, Esq.

1818, April 8th. [4234] William Annesley, of Belfast, Ireland, Architect.

1818, April. On a Spiral Oar for propelling Ships.

1818, June. On a Spiral Oar for propelling.

1818, July. On the Spiral as a motive power to impel Ships.

1818, Oct. 31st. [4294] Nicholas Desforges, of Bucklersbury, London, Merchant.

1819, March 4th. [4339] James Jeffray, of Glasgow, Scotland, Professor of Anatomy in the University of Glasgow.

1819, March 23rd. [4346] Thomas Morton, of Leith, Edinburgh, Scotland, Ship Builder.

1819, May 6th. [4361] Henry Booth, of Liverpool, Merchant.

1819, May 8th. [4363] James Mason, of Birmingham, Merchant.

1819, Dec. 4th. [4410] Samuel Lambert, of Princes Street, Leicester Square, Middlesex, Laceman.

1820, Jan. 15th. [4423] John Oldham, of South Cumberland Street, Dublin, Esq. Improvements in his former Patent, dated the 10th Oct. 1817.

1820, April 19th. [4444] George Lilly, of Brigg, Lincoln, Gentleman, and James Bristu Fraser, of Blackburn House, Linlithgow, in Scotland, Gentleman.

1820. On the Screw as a propelling instrument for Ships.

1820, May 15th. [4456] John Barton, of Falcon Square, London, Engineer.

1820, June 3rd. [4463] Simeon Teisseri, of Paris, in the Kingdom of France.

1821, Jan. 19th. [4523] Charles Phillips, of Albemarle Street, Piccadilly, Middlesex, Commander in our Royal Navy.

1821, May 5th. [4551] John Reedhead, of Heworth, Durham, Engineer and Mariner, and William Parrey, of East Lane, Walworth, Surrey, Master Mariner.

1821, July 23rd. [4566] Frederic Migells Van Heythuysen, of Chancery Lane, London.

1821, Nov. 10th. [4606] William Penrose, of Summerganges, York, Miller.

1821, Dec. 20th. [4623] John Gladstone, Engineer and Millwright, of Castle Douglas, Kirkcudbright, Galloway, North Britain.

1821, Dec. 22nd. [4626] George Linton, of Gloucester Street, Queen Square, Middlesex, Mechanist.

1822, Jan. 14th. [4633] David Gordon, of Edinburgh, Esq.

1822, Oct. 18th. [4706] Thomas Binns and Jonas Binns, both of Tottenham Court Road, Middlesex, Engineers.

1823. Curious Boat used at Nymphenburg.

1823, March 18th. [4757] Henry Abberley

Price, of Neath Abbey, Glamorganshire, Engineer.

1823, April 12th. [4767] John Martin Hanchett, of Crescent Place, Blackfriars, London.

1823, June 1st. Descriptions and Drawings of proposed improvements on the Paddle-wheel and other parts of the Machinery of Steam Boats.

1823, June 7th. Description of proposed improvements in the machinery of Steam Packets.

1824, Feb. 19th. [4898] The Reverend Moses Isaacs, of Houndsditch, London.

1824, June 29th. [4975] William Bush, of Broad Street, London, Merchant.

1824, July 13th. [4982] Charles Phillips, of Upper Finsbury, Kent, Esq.

1824. Description of a revolving Paddle-Scull, and the results of trials therewith.

1824, Aug. 9th. [4992] Jacob Perkins, of Fleet Street, London, Engineer.

1824. Memorial to the select committee of the Hon. the House of Commons by Mr. James Taylor.

1824, Sep. 16th. [4996] James Neville, of High Street, Southwark, Surrey, Engineer, and William Busk, of Broad Street, London, Esq.

1824, Nov. 11th. [5029] William Busk, of Broad Street, London, Esq.

1825, Feb. 26th. [5097] William Hopkins Hill, of Woolwich, Kent, Lieutenant in our Royal Artillery.

1825, March 15th. [5120] Samuel Brown, of Saville Row, Burlington Arcade, Middlesex, Commander in the Royal Navy.

1825, April 2nd. [5140] Simeon Broadmeadow, of Abergavenny, Monmouth, Civil Engineer.

1825, April 20th. [5147] John Broomfield, of Islington, near Birmingham, Engineer, and Joseph Luckcook, of Edgbaston, near Birmingham, Gentleman.

1825, May 14th. [5164] Goldsworthy Gurney, of Argyll Street, Hanover Square, Middlesex, Surgeon.

1825, July 26th. [5215] John Reedhead, of Heworth, Durham, Gentleman.

1825, Aug. 27th. [5239] William Parr, of Union Place, City Road, Middlesex, Gent.

1825. A short Narrative of Facts by Patrick Miller, Jun. Memoir, being an appendix to the above narrative, from the Edinburgh Philosophical Journal.

1825, Sept. 8th. [5241] Charles Mercy, of Edward's Buildings, Stoke Newington, Middlesex, Gentleman.

1825, Sept. 15th. [5242] William Jefferies, of No. 46, London Street, Ratcliffe Cross, Middlesex, Brass Manufacturer.

1825, Sept. 15th. [5245] George Holworthy Palmer, of the Royal Mint, Civil Engineer.

1825. Descriptions of a Screw Propeller, and experiments therewith.

1825, Sept. 15th. [5248] Sir Thomas Cochrane, Knight (commonly called Lord Cochrane), of Tonbridge Wells, Kent.

1825, Nov. 1st. [5266] John and Samuel Seaward, of the Canal Iron Works, St. Anne, Poplar, Middlesex, Engineers and Carpenters.

1825, Dec. 14th. [5302] Robert Addams, of Theresa Terrace, Hammersmith, Gentleman.

1826, Jan. 11th. [5311] Henry Anthony Koymans, of Warnford Court, Throgmorton Street, London, Merchant.

1826, July 24th. [5385] William Robinson, of Craven Street, Strand, Middlesex, Esq.

1826, Aug. 22nd. [5397] Timothy Burstall, of Leith, and John Hill, of Bath, Engineers.

1826, Oct. 18th. [5411] William Busk, of Broad Street, London, Esq.

1826, Oct. 18th. [5412] James Viney, of Shanklin, in the Isle of Wight, Colonel in our Royal Artillery, and George Pocock, of Bristol, Gentleman.

1826, Nov. 18th. [5416] Bennet Woodcroft, of Manchester, Engineer.

1826, Dec. 20th. [5425] Charles Harsleben, of Great Ormond Street, Queen's Square, Middlesex, Esq.

1826, Dec. 20th. [5430] Frederick Andrews, of Stanford Rivers, Essex, Gentleman.

1827, Jan. 15th. [5440] William Wilmot Hall, of Baltimore, in America, at present residing in Westminster, Middlesex, Attorney at Law.

1827, Jan. 15th. [5442] James Neville, of New Walk, Thames Street, Surrey, Engineer.

1827, Feb. 1st. [5447] John Oldham, of Dublin, Gentleman.

1827, Feb. 8th. [5453] Sir William Congreve, of Cecil Street, Strand, Middlesex, Baronet.

1827, Dec. 11th. [5571] Paul Steenstrop, of Basing Lane, London, Esq.

1827, Dec. 15th. [5578] Andrew Motz Skene, of Jermyn Street, Middlesex, Esq. a Lieutenant in the Royal Navy.

1827, Dec. 18th. [5579] John Lee Stevens, of Plymouth, Devon, Merchant.

1827, Dec. 19th. [5582] Thomas Stanhope Holland, of the City of London, Esq.

1827, Dec. 21st. [5583] William Harland, M.D. of Scarborough, York.

1827, Dec. 22nd. [5585] William Hule, of Colchester, Essex, Merchant.

1828, Jan. 19th. [5602] George Jackson, of St. Andrew, Dublin, Attorney at Law.

1828, Feb. 5th. [5606] William Nairn, of Dane Street, Edinburgh, Mason.

1828, March 20th. [5619] Nathan Gough, of Salford, Lancaster, Civil Engineer.

1828, April 3rd. [5628] Charles Harsleben, of New Ormond Street, Lambeth, Surrey, Engineer.

1828, April 29th. [5635] Charles Carpenter Bompas, of the Inner Temple, Esq.

1828, July 5th. [5661] John Johnstone Isaac, of Star Street, Edgeware Road, Middlesex, Engineer.

1828, Sept. 4th. [5684] John and Samuel Seaward, of the Canal Iron Works, Poplar, Middlesex, Engineers.

1828, Sept. 18th. [5697] John Melville, of Upper Harley Street, Cavendish Square, Middlesex, Esq.

1828, Oct. 9th. [5705] Thomas Tippott, of Givennap, Cornwall, Engineer.

1828, Dec. 10th. [5721] Charles Cummerow, of Lawrence, Poutney Lane, Cannon Street, City of London, Merchant.

1828, Dec. 15th. [5727] Richard Williams, of Tabernacle Walk, Middlesex, Civil Engineer.

1828, Dec. 15th. [5728] Anton Bernhard, of Finsbury Circus, Engineer.

1828, Dec. 18th. [5733] William Steade, of Guidersome, York, Millwright and Machine Maker, and James Stead, of Doncaster, York, Wood Valuer.

1829, Jan. 7th. [5740] Orlando Harris Williams, of North Nibley, Gloucester, Esq.

1829, Jan. 7th. [1541] Septimus Gritton, of Pentonville, Middlesex, Surgeon, and late of our Royal Navy.

1829, Jan. 7th. [5742] Francis Neal, of Gloucester, Barrister at Law.

1829, Jan. 7th. [5745] Archibald Robertson, Liverpool, Ship Carver.

1829, Jan. 14th. [5750] William Erskine Cochrane, of Regent Street, Middlesex.

1829, Feb. 3rd. [5756] Julius Pumphrey, of Tally Hill, Worcester, Glover.

1829, April 28th. [5775] Peter Pickering, native of Frodsham, Cheshire, and now of Danzig, Prussia, and William Pickering, of Liverpool, Merchants.

1829, May 19th. [5780] James Dutton, Jun., of Wootton-under-Edge, Gloucester, Clothier.

1829, May 21st. [5781] Maxwell Dick, of Irvine, Ayrshire, North Britain, Bookseller and Publisher.

1829, May 26th. [5784] William Poole, of Saint Michael-on-the-Mount, Lincoln, Smith.

1829, June 1st. [5788] William Mann, of Effra Road, Brixton, Surrey, Gentleman.

1829, July 2nd. [5796] Elijah Galloway, of King Street, Southwark.

1829, July 2nd. [5796] Jacob Perkins, of Fleet Street, London, Engineer.

1829, July 4th. [5799] Robert Crabtree, of Halesworth, Suffolk, Gentleman.

1829, Sept. 30th. [5844] John Moore, of Broad Weir, Bristol, Gentleman.

1829, Oct. 15th. [5843] William Church, of Heywood House, near Birmingham, Esq.

1830, Jan. 12th. [5870] William Hale, of Colchester, Essex, Machinist.

1830, Feb. 27. William Grisenthwaite, of Nottingham, Esq.

1830, March 20th. [6011] George Scott, of Water Lane, London, Engineer.

1830, April 14th. [6018] William Altoft Summers, of Saint George's Place, Saint George's in the East, Middlesex, Engineer, and Nathaniel Ogle, of Milbrook, Hants, Esq.

1830, July 19th. [6048] Thomas Bulkerley, of Albany Street, Regent's Park, Middlesex, M. D.

1830, Aug. 5th. [6054] John Ruthven, of Edinburgh, Engineer and Manufacturer.

1830, Aug. 18th. [6075] Major-General Joseph Gubbins, of Southampton, Hampshire.

1830, Oct. 6th. [6097] John Heaton, William Heaton, George Heaton, and Reuben Heaton, of Birmingham, Manufacturers and Co-partners.

1830, Nov. 4th. [6118] Thomas Bramley, Gentleman, and Robert Parker, Lieutenant in the Royal Navy, both of Monsley Priory, Surrey.

1830, Nov. 29th. [6132] William Church, of Heywood House, Warwick, Esq.

1830, Dec. 6th. [6136] Samuel Brown, of Billiter Square, London, Commander in the Royal Navy.

1830, Dec. 13th. [6143] Richard Witty, of Busford, Wolstanton, Stafford, Engineer.

1831. An account of the origin of steam boats in Spain, Great Britain, and America, by R. P. Cruden.

1831, Jan. 15th. [6151] Samuel Seaward, of the Canal Iron Works, Poplar, Middlesex, Engineer.

1831. Remarks on Canal Navigation, illustrative of the advantages of the use of steam as a moving power on Canals, &c., by Wm. Fairbairn, Engineer, London.

1831, Jan. 22nd. [6153] Andrew Smith, of Princes Street, London.

1831, March 4th. [6181] David Napier, of Warren Street, Fitzroy Square, Middlesex, Engineer, and James Napier and William Napier, of Glasgow, Engineers.

1831, April 2nd. [6194] James Slater, of Salford, Lancaster, Bleacher.

1831, May 24th. [6211] Samuel Hobday, of Birmingham, Steel Snuffer and Toy Manufacturer.

1831, July 13th. [6225] Moses Poole, of the Patent Office, Lincoln's Inn, Middlesex, Gentleman.

1831, Aug. 3rd. [6238] Sir James Caleb Anderson, of Buttervant Castle, Cork, Ireland, Baronet.

1831, Aug. 10th. [6241] Alexander Cochrane, of Norton Street, Great Portland Street, Middlesex, Esq.

1831, Sept. 16th. [6252] George Holworthy Palmer, of Manchester Street, Gray's Inn Road, Middlesex, Civil Engineer.

1831, Sept. 28th. [6262] Oliver Saint George, of Great Cumberland Street, Middlesex, Esq.

1831, Sept. 28th. [6263] Miles Berry, of the Office for Patents, 66, Chancery Lane, Holborn, Middlesex, Engineer and Mechanical Draftsman.

1831, Oct. 13th. [6271] William Hale, of Colchester, Essex, Machinist.

1832, Jan. 17th. [6303] Elijah Galloway, of Blackfriars Road, Surrey, Engineer.

1832, March 22nd. [6341] Bennet Woodcroft, of Manchester, Engineer.

1832, Aug. 15th. [6388] William Henry James, of Thavies Inn, Holborn, Engineer.

1832, Sept. 22nd. [6399] Richard Trevithick, of Cambourne, Cornwall, Engineer.

1832, Nov. 7th. [6420] Elijah Galloway, of Carter Street, Walworth, Surrey, Engineer.

1832, Dec. 17th. [6437] Joseph Hardwick, of Liverpool, Gentleman.

1833, Jan. 22nd. [6459] Joseph Saxton, of Sussex, Middlesex, Mechanician.

1833, Jan. 22nd. [6459] John Mc Curdy, of Southampton Row, Middlesex.

1833, Jan. 29th. [6468] John Reedhead, of Henry Street, Vauxhall, Surrey, Esq.

1833, April 15th. Description and drawings of proposed improvements in paddle wheels.

1833. Description and drawing of proposed improvements in steam boats.

1833. A brief narrative proving the right of the late William Symington to be considered the inventor of Steam Navigation, by Robert Bowie. London, 1833.— Extracts from Scientific Works, &c., and Symington's Testimonials.

1833, Feb. 21st. [6479] Luke Herbert, of Hampstead Road, Middlesex, Civil Engineer, and James Don, of No. 9, Lower James Street, Golden Square, Westminster.

1833, Feb. 21st. [6481] Alexander Gordon, of the Strand, Middlesex, Engineer.

1833, June 1st. [6522] George Carter, of Nottingham Lodge, Kent, Gentleman.

1833, Oct. 7th. [6572] William Tanner Young, of Liverpool, Merchant.

1833, Nov. 19th. [6598] Robert Joseph Brandling, of Low Gosforth, Northumberland, Esq.

1833, Dec. 19th. [6617] Thomas Sunderland, of Blackheath, Kent, Esq.

1833, Dec. 21st. [6625] John Howard Kyan, of Upper Baker Street, Middlesex, Esq.

1834, March 1st. [6661] Henry Pinkus, late of Pennsylvania, in America, now of North Crescent, Bedford Square, Middlesex, Gentleman.

1834, March 29th. [6676] John Cooper Douglas, of Great Ormond Street, Middlesex.

1834, May 6th. [6694] William Alfred

Noble, of Cross Street, Cherrey Garden Street, Bermondsey, Surrey, Engineer.

1834, June 23rd. [6721] William Symington, of Bromley, Middlesex, Cooper, and Andrew Symington, of Falkland, in Fifeshire, Scotland, Watch-maker.

1834, July 1st. Mode of propelling steam vessels without paddles.

1834, July 26th. [6741] Thomas John Hamilton, Earl of Orkney, and John Easter, Engineer, both of Taplow, Bucks.

1834, Oct. 10th. [6781] John Ericsson, of Union Wharf, Albany Street, Regent's Park, Middlesex, Engineer.

1834, Oct. 18th. On the propulsion of vessels from the stern.

1834, Nov. 20th. [6809] Robert Whiteside, of Air, in the County of Air, Wine Merchant.

1835, Feb. 9th. [6850] James Seeming, of Manchester, Worsted Spinner.

1835, Feb. 9th. [6851] James Halstead, of Burr Street, Saint Catherine's, Middlesex, Sail-maker.

1835, Feb. 25th. [6862] William Aitkin, of Aberdeen, North Britain, Esq.

1835, March 16th. [6881] William Church, of Heywood House, Bordesley Green, near Birmingham.

1835, April 14th. [6905] James Boydell, Junior, of Dee College, Chester, Gentleman.

1835, June 2nd. [6935] William Wilkinson, of Lucas Street, Commercial Road, Saint George's in the East, Middlesex, Engineer.

1835, July 9th. [6947] Henry Vint, of Linden, Colchester, Essex.

1835, July 10th. [6949] William Busk, of Bankside, Surrey, Engineer.

1835, July 10th. [6950] John Rogers, of Prince's Court, Westminster, Middlesex, Gentleman.

1835, July 13th. [6952] Frederick Herbert Maberley, of Bowen, Cambridge, Clerk.

1835, Aug. 17th. [6975] Henry Pinkus, late of Pennsylvania, in America, but now of Oxford Street, Middlesex, Gentleman.

1835, Aug. 18th. [6977] Elijah Galloway, of Wellington Terrace, Waterloo Road, Surrey.

1835, Aug. 26th. [6982] John Lane Higgins, of Oxford Street, Middlesex, Esq.

1835, Nov. 7th. [7015] William Symington, of Bromley, Middlesex, Cooper.

1835, Dec. 21st. [7053] John Baillie, of Great Suffolk Street, Southwark, Surrey, Engineer, and John Patterson, of Mincing Lane, London, Gentleman.

1836, Jan. 19th. [7074] Charles Harseleben, of No. 95, Bold Street, Liverpool, Esq.

1836, Jan. 26th. [7080] Henry Pickworth the younger, of Sipson, Middlesex, Gentleman.

1836, Feb. 1st. [7083] Stephen Reed, of Newcastle-upon-Tyne, Gentleman.

1836, Feb. 9th. [7088] Alexander Massie, of Saint John, Wapping, Middlesex, Engineer, Robert Merton, of the same place, Engineer, William Ranwell, of Woolwich, Kent, Coal Merchant, and Ebenezer Runwell, of the same place, Miller.

1836, Feb. 17th. [7097] William Bucknall, of Crutched Friars, London, Cork Merchant,

1836, March 21st. [7127] Walter Hancock, of Stratford, Engineer.

1836, March 22nd. [7130] William Hale, of Greenwich, Kent, late of Colchester, Essex, Engineer.

1836, March 23rd. [7133] Sir John Scott

Lillie, Knight and Companion of the Most Honourable Military Order of the Bath, of Saint John's, Fulham, Middlesex.

1836, April 26th. [7162] William Taylor, of Smethwick, Stafford, Engineer, and Henry Davis, of Stoke Prior, Worcester, Engineer.

1836, May 31st. [7194] Francis Pettit Smith, of Hendon, Middlesex, Farmer.

1836, June 24th. [7225] Samuel Hall, of Bashford, Nottingham, Gentleman.

1836, July 11th. [7234] Matthew Heath, of Furnival's Inn, London, Esq.

1836, July 13th. [7239] John Ericsson, of Brook Street, New Road, Middlesex, Civil Engineer.

1836, Aug. 11th. [7258] Edward Light, of Royal Street, Lambeth, Civil Engineer.

1836, Aug. 25th. [7266] François de Tanch, of Percy Street, Bedford Square, Military Engineer to the King of Bavaria.

1836, Dec. 3rd. [7328] David Nimes Carvalho, of Fleet Street, London, Bookseller.

1837, Jan. 19th. [7378] William Stedman Gillett, of Guildford Street, Middlesex, Gentleman.

1837, Feb, 6th. [7387] John Gemmell, of Stockwell Street, Glasgow, Merchant.

1837, Feb. 16th. [7391] Richard Burch, of Heywood, Lancaster, Machinist.

1837, April 4th. [7424] Michael Berand Lauras, of Lyons, but now residing in Leicester Square, Middlesex, Merchant.

1837, April 25th. [7441] Sir George Cayley, Baronet, of Brompton, near Malton, York.

1837, April 25th. [7442] James Pimm, Jun. of College Green, Dublin, Banker, and Thomas Fleming Bergin, of Westland Row, in the same City, Civil Engineer.

1837, May 8th. [7458] John Spurgin, of Guildford Street, Russell Square, Middlesex, Doctor of Medicine.

1837, May 11th. [7460] James Boydell, Jun., of Dee Cottage, near Hawarden, Flint, Esq.

1837, June 6th. [7476] Miles Berrey, of Chancery Lane, Holborn, Middlesex, Mechanical Draftsman.

1837, Sept. 7th. [7519] William James Gifford, of Gloucester Place, Middlesex, Surgeon.

1837, Sept. 14th. [7521] Thomas John Cave, of Rodney Street, Pentonville, Middlesex, Surgeon.

1837, Oct. 20th. [7539] Henry Robinson Palmer, of Great George Street, Westminster, Civil Engineer.

1837, Dec. 19th. [7601] John Gray, of Liverpool, Engineer.

1837, Dec. 19th. [7608] William Sandford Hall, of Strathearn Cottage, Chelsea, Middlesex, Lieutenant in the Army.

1837, Dec. 23rd. [7613] John Elvey, of Canterbury, Kent, Millwright.

1838, Jan. 18th. [7633] Julien Augustus Tarner, of No. 2, Henry Street, Liverpool, Architect.

1838, Feb. 8th. [7653] Robert Essex, of St. Mary, Islington, Middlesex, Silversmith.

1838, Feb. 27th. [7668] Josiah Pearce Holbrook, of Devonshire Place, Edgware Road, Middlesex, Gentleman.

1838, March 8th. [7675] William Hale, of Greenwich, Kent, Engineer.

1838, March 24th. [7688] James Lowe, of King Street, Old Kent Road, Surrey, Mechanic.

1838, April 10th. [7701] David Redmund, of Wellington Foundry, Charles Street, City Road, Middlesex, Engineer.

1838, May 1st. [7718] Joseph Jepson Oddy Taylor, of Gracechurch Street, London, Machinist.

1838, June 5th. [7760] Samuel Parlour, of Croydon, Surrey, Gentleman.

1838, June 14th. [7780] Richard Goodridge, of No. 7, Bell's Buildings, Salisbury Square, London, Purser in her Majesty's Navy.

1838, July 11th. [7818] Louis Cyprion Callet, late of New York, in America, but now residing in Manchester, Merchant.

1838, July 11th. [7819] Henry Van Wart, of Birmingham, Merchant; Samuel Aspinall Goddard, of the same place, Merchant.

1838, July 26th. [7834] John Gray, of Liverpool, Engineer.

1838, July 26th. [7838] Frederick Edward Fraissinet, of Covent Garden Square, Westminster, Middlesex.

1838, Aug. 15th. [7860] Ramsay Richard Reinagle, of No. 13, George Street, London University, Royal Academician, and the Chevalier George Robert D'Harcourt, of No. 6, King William Street, London, Civil Engineer.

1238, Aug. 30th. [7879] Lawrence Heyworth, of Yew Tree, near Liverpool, Merchant.

1838, Aug. 30th. [7881] Joseph Curtis, of Stamford Street, Blackfriars Road, Surrey, Civil Engineer.

1838, Sept. 6th. [7886] Timothy Burstall, of Leith, Scotland, Engineer.

1838, Sept. 8th. [7889] Samuel Ulric Vaucher, of Geneva, in Switzerland, but now residing in Manchester, Gentleman.

1838, Sept. 13th. [7902] Sir Hugh Pigot, of Foley Place, Marylebone, Middlesex, Knight.

1838, Sept. 27th. [7910] John Hughes Rees, of Penymaes, near Llanelly, Carmarthen, Esq.

1838, Nov. 13th. [7959] George Smith, of the Naval Club House, Bond Street, Middlesex, a Captain in the Royal Navy.

1838, Dec. 1st. [7973] Peter Taylor, of Birchin Bower, within Chadderton, Lancaster, Rope Maker.

1839, Jan. 17th. [8029] William Holme Higginbothom, of Stockport, Chester, Gentleman.

1839, Jan. 22nd. [8035] John Coope Haddan, of Bazing Place, Waterloo Road, Surrey, Civil Engineer.

1839, March 6th. [8082] John Clark, at present residing in Upper Thames Street, London, Engineer.

1839, March 20th. [8094] John Ruthren and Morris West Ruthever, of Edinburgh, Civil Engineers.

1839, March 26th. [8103] Edmund Butler Rowley, of Manchester, Surgeon, R. N.

1839, April 23rd [8134] Antonie Movillon, of Dorset Place, Dorset Square, Middlesex, Gentleman.

1839, April 23rd. [8135] George Holworthy Palmer, of Surrey Square, Old Kent Road, Surrey, Civil Engineer.

1839, July 6th. [8235] John Ericsson, of Cambridge Terrace, Hyde Park, Middlesex, Civil Engineer.

1839, July 13th. [8239] William Woodley, of Observatory House, Woodbury Vale, Stoke Newington, Middlesex, Captain R. N.

1839, July 29th. An Act for forming and regulating a Company to be called the 'Ship Propeller Company.'

1839, Aug. 16th. [8286] William Bridges Adams, of Porchester Terrace, Bayswater, Middlesex, Gentleman, and John Buchanan, of Glasgow, in North Britain, Coach Builder.

1839. In Parliament, Reasons against the 'Ship Propeller Company Bill.'

1839. In Parliament, Answers to Reasons against the Bill.

1839, Aug. 23rd. [8293] William Coles, of Charing Cross, Middlesex, Esq.

1839, Sept. 19th. [8312] Thomas Todd, of Kingston-upon-Hull, York, Gentleman.

1839, Oct. 7th. [8322] Samuel Hall, of Basford, Nottingham, Engineer.

1839, Oct. 10th. [8325] John Barnett Humpherys, of Southampton, Civil Engineer.

1839, Oct. 10th. [8327] James Smith, of Deanston Works, Kilmardock, Perthshire, Cotton Spinner.

1839, Oct. 14th. Drawing of 'Archimedes' steam vessel, and an account of her performances.

1839, Nov. 19th. [8363] Francis Worrall Stevens, of Chigwell, Essex, Schoolmaster.

1839, Nov. 23rd. [8369] John Hunt, of Greenwich, Kent, Engineer.

1839, Nov. 26th. [8375] George Rennie, of Holland Street, Blackfriars, Surrey, Civil Engineer.

1839, Dec. 4th. [8385] Christopher Nickols, of York Road, Lambeth, Surrey, Gentleman.

1840, Jan 1st. [8420] John Lee Nicholas, of Clifton, Bristol, Gentleman.

1840, Feb. 8th. [8466] Joseph Needham, of Plymouth, a Post Captain in the Royal Navy.

1840, March 3rd. [8499] John Rangeley, of Camberwell, Surrey, Gentleman.

1840, March 17th. [8525] Samuel Seaward, of the Canal Iron Works, Poplar, Middlesex, Engineer.

1840, June 9th. [8628] John George Shuttleworth, of Feamley Place, Glossop Road, Sheffield, York, Gentleman.

1840, June 11th. [8631] Benjamin Windle, of Northampton Street, Islington, Middlesex, Steel and Copper-Plate Manufacturer.

1840, June 13th. [8633] Ezra Jenks Coates, of Bread Street, Cheapside, London, Merchant.

1840, June 13th. [8634] Edward John Carpenter, of Tofts Monks, Norfolk, a Commander in the Royal Navy.

1840, Aug. 7th. [8682] Henry Trewhitt, of Newcastle-on-Tyne, Northumberland, Esq.

1840, Aug. 14th. [8692] Miles Berrey, of Chancery Lane, Middlesex, Patent Agent.

1840, Sept. 17th. [8721] Henry Fourdrinier and Edward Newman Fourdrinier, both of Hanley, Stafford, Paper-makers.

1840, Sept. 22. [8727] Thomas Pain, Jun., of 57, Upper Seymour Street, Euston Square, Middlesex, Student at Law.

1840, Sept. 24th. [8733] Henry Pinkus, of Panton Square, Coventry Street, Middlesex, Esq.

1840, Nov. 2nd. [8758] Elijah Galloway, of Manchester Street, Middlesex, Engineer.

1840, Nov. 2nd. [8760] Henry Wimshurst, of Limehouse, Middlesex, Ship Builder.

1840, Nov. 3rd. [8767] John Rapson, of Limehouse, Middlesex, Millwright.

1840, Nov. 25th. [8303] Henry Charles Danberry, late of Windsor, Berkshire, but now residing at Boulogne, France, Esq.

1840, Nov. 28th. [8818] George Blaxland, of Greenwich, Kent, Engineer.

1841, Jan. 21st. [8894] John Melville, of Upper Harley Street, Middlesex, Esq.

1841, Feb. 8th. [8929] Joseph Scott, of Great Bowden, near Market Harborough, Leicester, Timber Merchant.

1841, Feb. 15th. [8934] James Whitelaw and George Whitelaw, Engineers, residing in Glasgow, Scotland.

1841, March 22nd. [8977] Joshua Field, of Lambeth, Surrey, Engineer.

1841, March 22nd. [8982] David Napier, of Mill Wall, Middlesex, Engineer.

1841, March 25th. [8990] Edward Finch, of Liverpool, Ironmaster.

1841, May 26th. [9059] William Joest, of Ludgate Hill, London, Middlesex.

1841, June 5th. [9065] William Hannis Taylor, of Lambeth, Surrey, Esq.

1841, June 5th. [9066] Joseph Gibbs, of the Oval, Kennington, Surrey, Civil Engineer.

1841, June 10th. [9070] John George Bodmer, of Manchester, Engineer.

1841, June 19th. [9083] Sir Samuel Brown, Knight of the Royal Hanoverian Order, Commander in her Majesty's Navy, of Netherbyers House, Ayton, Berwick.

1841, June. New mode of driving steam boats.

1841, June 19th. [9084] John George Truscott Campbell, of Lambeth Hill, Upper Thames Street, Grocer.

1841. Enrolled Memorials of 'Ship Propeller Company.'

1841, July 28th. [9127] Anthony Bernhard von Rathen, of Kingston-upon-Hull, Engineer.

1841, Aug. 4th. [9129] Owen Williams, of Basing Lane, London, Engineer.

1841, Aug. 4th. [9132] Stopford Thomas Jones, of Tavistock Place, Russell Square, Middlesex, Gentleman.

1841, Sept. 6th. [9157] Pierre Pelleton, of Paris, and now residing in Saint Paul's Church Yard, London, Professor of Medicine of the Faculty of Paris.

1841, Sept. 17th. [9174] Conrad Frederick Stollmeyer, of Golden Terrace, Barnsbury Road, Islington, Middlesex, Merchant.

1841, Dec. 16th. [9268] Francis Marx, of 81, Eaton Square, in the county of Middlesex, Esq.

1841, Dec. 16th. [9273] Henry Booth, of Liverpool, Esq.

1841, Dec. 16th. [9280] Charles Loosey, of Half Moon Street, Piccadilly, in the county of Middlesex, Civil Engineer.

1841, Dec. 21st. [9295] William Burge, of the city of Bristol, Sign Painter.

1842. Description of Booth's New System of Propulsion.

1842, Jan. 11th. [9306] Richard Dover Chatterton, of Derby, in the county of Derby, Gentleman.

1842, Feb. 8th. [9338] Benjamin Biram, of Wentworth, Yorkshire, Colliery Viewer.

1842, March 14th. [9383] Charles William Firchild, of Wesley Park, Northfield, Worcester, Farmer.

1842. A concise History of Steam Navigation, by Mr. James Taylor, Edinburgh. 1842.

1842, May 11th. [9437] John Melville, of Upper Harley Street, Middlesex, Esq.

1842, June 21st. [9487] John Dickson, of Brook St. Holborn, Middlesex, Engineer.

1842, June 21st. [9489] Thomas Gaunt, of No. 12, Dalby Terrace, City Road, Middlesex, Gentleman.

1842, July 7th. [9500] John Bird, of Manchester, Machinist.

1842, July 23rd. [9516] Alexander Johnson, of Hill House, in the county of Edinburgh, Esq.

1842, July 28th. [9517] Edward Cobbold, of Melford, Suffolk, Master of Arts, Clerk.

1842, Aug. 18th. Martin's swan foot paddle oar for propelling.

1842, Sept. 9th. [9558] James Wake, Junior, of Goole, York, Coal Factor.

1842, Sept. 16th. [9562] William Henry James, of Martin's Lane, London, Civil Engineer.

1842, Sept. 29th. [9567] Samuel Henson, of No. 26, New City Chambers, Bishopsgate Street, London, Engineer.

1842, Nov. 8th. [9605] Henrick Zander, of North Street, Sloane Street, Engineer.

1842, Dec. 8th. [9639] John Grantham, of Liverpool, Engineer.

1842, Dec. 15th. [9649] James Winchester, of Noel Street, Middlesex, Hatter.

1842, Dec. 21st. [9651] Gabriel Hippolyte Moreau, of Leicester Square, Middlesex, Gentleman.

1843, Jan. 19th. [9681] James Hamer, of Wardour Street, Middlesex, Engineer.

1843, Jan. 19th. [9682] Thomas, Earl of Dundonald, of Regent's Park, Middlesex.

1843, Jan. 19th. [9687] Thomas Sunderland, of Albany Street, Regent's Park, Middlesex, Esq.

1843, March 7th. [9746] James Pilbrow, of Tottenham, Middlesex, Engineer.

1843, April 20th. [9790] John George Bodmer, of Lancaster, Engineer.

1843, April 20th. [9792] Edward Cobbold, of Melford, Suffolk, Master of Arts, Clerk.

1843, April 20th. [9794] James Johnson, of Willow Park, Greenock, Esq.

1843, May 16th. [9820] John Winter Walker, Jun., of Glasgow, Merchant.

1843, May 25th. [9831] Elijah Galloway, of Seymour Street, Euston Square, Saint Pancras, Middlesex, Civil Engineer.

1843, June 8th. [9846] Robert Smart, of Commercial Road, Saint Mary Radcliffe, Bristol, Ship Owner.

1843, June 15th. [9870] William Edward Newton, of Chancery Lane, Middlesex, Civil Engineer.

1843, July 1st. [9897] James Lancaster Lucena, of Garden Court, Middle Temple, London, Barrister at Law.

1843, July 6th. [9913] James Joseph Bennet, of Limehouse, Middlesex, Esq.

1843, July 10th. [9916] Jacob Samuda, of Southwark Iron Works, Surrey, Engineer.

1843, July 13th. [9920] Joseph Maudesley, of Lambeth, Surrey, Engineer.

1843, July 13th. [9922] Henry Pinkus, of No. 1, Duke Street, Portland Place, Middlesex, Esq.

1843, Aug. 3rd. [9946] Peter Borrie, of Prince's Square, Saint George's in the East, Middlesex, Engineer, and Mayer Henry, of Crutched Friars, London.

1843, Aug. 14th. [9951] John Wood, of Parkfield, Birkenhead.

1843, Nov. 2nd. [10,005] John Kebble, of Glasgow, Gentleman.

1843, Nov. 21st. [10,043] Moses Poole, of Lincoln's Inn, Middlesex, Gentleman.

1844, Jan. 13th. [10096] Robert Flouerton, of the Jamaica Coffee House, Cornhill, London, Master Mariner.

1844. Accounts of experiments on a vessel called the Liverpool screw.

1844, Jan. 13th. [10097] Anthony Movillon de Glimes, of Panton Street, Haymarket, Middlesex, Gentleman.

1844, Jan. 25th. [10111] Henry Davis, of Norbury, Stafford, Engineer.

1844, Feb. 2nd. [10121] Robert Hodgson, of Prince's Street, Clapham Road, Surrey, Engineer.

1844, Feb. 8th. [10132] William Edward Newton, of Chancery Lane, Civil Engineer.

1844, Feb. 13th. [10138] Bennet Woodcroft, of Manchester, Engineer,

1844, March 7th. [10181] William Fairbairn, of Manchester, Engineer.

1844, April 23rd. [10241] Peter Lear, of Boston, Suffolk, in the State of Massachusetts of the United States of America, Gentleman.

1844, April 27th. [10248] Isaiah Davies, of Birmingham, Engineer.

1844, May 17th. [10276] John McIntosh, of the City of Glasgow, Scotland, Gentleman.

1844, May 17th. [10277] James Pilbrow, of Tottenham, Middlesex, Civil Engineer.

1844, May 30th. [10292] Charles Anthony Deane, of Poplar, Middlesex, Inventor of the Diving Apparatus.

1844, June 4th. [10299] William Henry Phillips, of Bloomsbury Square, Middlesex, Engineer.

1844, June 21st. [19319] Pierre Armand Lecompte de Fontainemoreau, of Skinner's Place, Size Lane, London.

1844, July 3rd. [10326] Guy Carleton Coffin, of Sandford, Wilts, Esq.

1844, July 3rd. [10330] John George Bodmer, of Manchester, Engineer.

1844, July 3rd. [10331] Christopher Dunkin Hays, of Bermondsey, Surrey, Wharfinger.

1844, Sept. 12th. [10403] Elias Robinson Hancock, of Rothmoyle House, in the Queen's County, Ireland, and No. 16, Regent Street, London.

1844, Oct. 14th. [10436] Sir Graham Eden Hammond, Baronet, Vice-Admiral in Her Majesty's Navy, and Knight Commander of the most Honorable Order of the Bath, of Norton Lodge, Yarmouth, Isle of Wight.

1844, Dec. 7th. [10512] William Willcocks Sleigh, of Saint James's Square, Surgeon.

1844, Dec. 21st. [13531] Benjamin Biram, of Wentworth, in the County of York, Gentleman.

1845, Jan. 2nd. [10538] William Hannis Taylor, of West Strand, Middlesex, Gentleman.

1845. Account of Grantham's Patent Engines for driving screw propellers.

1845. Carpmael's opinion thereon.

1845, Jan. 11th. [10543] George Spence, of Hungerford Street, West Strand, Middlesex, Engineers' Draftsman.

1845, Jan. 11th. [10549] Henry Cartwright, of the Dean, near Brosley, Salop, Farmer.

1845, Jan. 21st. [10569] John Melville, of Upper Harley Street, Middlesex, Esq.

1845, Feb. 5th. [10595] John Seaward, of the Canal Iron works, Poplar, Middlesex, Engineer,

Darius Isaac Green, of No. 7, Villiers Street.

1845, Feb. 8th. [10596] Strand, Middlesex, Gentleman.

1845, Feb. 20th. [10616] Samuel Hall, of King's Arms Yard, Coleman Street, London, Civil Engineer.

1845, March 3rd. [10629] Alexander Gordon, of Fludyer Street, Westminster, Middlesex, Member of the Institution of Civil Engineers.

1845, March 13th. [10643] John and Alfred Blyth, of the Parish of Saint Anne, Middlesex, Engineers, Co-partners, and George Parker Hubbuck, of Ponder's End, Middlesex, Engineer.

1845, March 27th. [10664] John Baptiste Simion Teisser, of Paris, Engineer; and Antoine Hyppolyte Triut, of Paris, Professor of Gymnastics.

1845, April 7th. [10681] Thomas Metcalf, of Elizabeth Street, Eaton Square, Middlesex, Brush-maker.

1845, April 10th. [10692] Elijah Galloway, of the Strand, Middlesex, Engineer.

1845, April 24th. [10723] Joseph Maudsley, and Joshua Field, of Lambeth, Surrey, Engineers.

1845, May 8th. [10746] George Duckett Barber Beaumont, of Sandy Combe Lodge, Twickenham, Middlesex.

1845, May 10th. [10748] William Prosser, Jun., of Pimlico, Esq., and Jacob Brett, of Hanover Square, both in the County of Middlesex.

1845, May 27th. [10778] Henry Pinkus, of No. 51, Great Marlborough Street, Middlesex, Esq.

1845, June 3rd. [10794] Thomas Lawes, of Old Kent Road, Surrey, Gentleman.

1845, June 12th. [10809] Frederick Rosenberg, of Kingston-upon-Hull, York, Gentleman.

1845, June 23rd. [10822] Robert Griffiths, of Havre, France, George Hinton Bovill, of Millwall, Middlesex, and George Honnett, of Bristol, Engineers.

1845, July 3rd. [10841] William Newton, of the Office for Patents, 66, Chancery Lane, Middlesex, Civil Engineer.

1845, July 8th. [10846] Jacob Brett, of Hanover Square, Middlesex, Esq.

1845, July 12th. [10849] John Samuel Templeton, of Sussex Place, Kensington, Middlesex, Dentist.

1845, July 12th. [10858] Joseph Malcomson, of Portlaw, in the County of Waterford, Ireland.

1845, July 29th. [10877] George Beudon, of Battersea, in the County of Surrey, Commander in the Royal Navy.

1845, July 29th. [10878] Sir Samuel Brown, of Blackheath, Knight of the Hanoverian Guelphic Order, Captain in Her Majesty's Navy.

1845, Aug. 22nd. [10907] Thomas Oxley, of Westminster Road, in the County of Surrey, Civil Engineer.

1845, Oct. 2nd. [10929] John Reed Hill, of 28, Stamford Street, Lambeth, in the County of Surrey, Civil Engineer.

1845, Oct. 9th. [10945] John Luke, of Apsley, in the County of Herts, Civil Engineer.

1845, Nov. 17th. [11032] Stephen R. Parkhurst, of Liverpool, in the County of Lancaster, Machinist.

1845, Nov. 20th. [11049] Samuel Parlour, of Holloway, in the County of Middlesex, Gentleman.

1845, Dec. 10th. [11083] Christopher Donkin Hays, of Bermondsey, in the County of Surrey, Master Mariner.

1845, Dec. 20th. [1196] William Hannis Taylor, of Piccadilly, in the County of Middlesex, Gentleman, and Francis Rubiliac Conder, of Birmingham, in the County of Warwick, Civil Engineer.

1845, Dec. 23rd. [11104] William Penn, of Greenwich, in the County of Kent, Engineer and Manufacturer of Steam Engines, William Hartree, Jun., and John Mather, of Greenwich aforesaid Engineers.

1846, Jan. 3rd. [11111] Thomas Swinburne, of Lincoln's Inn, in the County of Middlesex, Esq.

1846, Jan. 12th. [11122] James Seaward, of the Canal Iron Works, in the County of Middlesex, Engineer.

1846, Jan. 13th. [11126] Joseph Maudsley, of the firm of Messrs. Maudsley and Field.

1846, Jan. 20th. [11131] Peter Taylor, of Hollinwood, Near Manchester, Machinist.

1846, Jan. 20th. [11140] John Spencely, of Whitstable, in the County of Kent, Master Block-maker.

1846, Jan. 31st. [11156] James Pilbrow, of Tottenham, in the County of Middlesex, Civil Engineer.

1846, Feb. 3rd. [11159] Samuel Brown, of Gravel Lane, in the County of Surrey, Engineer.

1846, Feb. 25th. [11188] Alexander Thompson, of Connaught Terrace, Hyde Park, Gentleman, and Joseph Wright, of Holborn Bars, Mechanic, both in the County of Middlesex.

1846, Feb. 27th. [11201] John Samuel Templeton, of Sussex Place, Kensington, in the County of Middlesex, Artist.

1846, March 21st. [11224] Bennet Woodcroft, of Manchester, Engineer, prolongation of Patent of 21st March, 1832. [6331].

1846, March 25th. [11239] Joseph Needham Taylor, of Chelsea, Middlesex, Captain in Her Majesty's Navy.

1846, May 5th. [11282] John Carter, of Fleur-de-lis Street, in the City of London, Ivory Merchant.

1846, May 13th. [11296] Julius Jeffreys, of Norfolk Crescent, Hyde Park, Gentleman.

1846, May 24th. [11308] James Montgomery, of Salisbury Street, in the County of Middlesex.

1846, June 29th. [11360] Sir James Caleb Anderson, of Buttevant Castle, in the County of Cork, Ireland, Baronet.

1846, Aug. 15th. [11422] John Buchanan, of Queen's Square, Westminster, Gentleman.

1846, Aug. 26th. [11439] Henry Bessemer, of Baxter House, Old Saint Pancras Road, in the County of Middlesex, Engineer.

1846, Sep. 25th. [11473] Thomas Bartlett Simpson, of Islington, in the County of Middlesex, Gentleman.

1846, Oct. 1st. [11474] Albert Robert Cunningham, of Sydenham, in the County of Kent, Gentleman, and Joseph Threlfall Carter, of the same place, Engineer.

1846, Oct. 15th. [11503] Ebenezer Southworth, of Chorlton-upon-Medlock, near Manchester, in the County of Lancaster, Draper.

1846, Dec. 2nd. [11556] William Johnson, of Grosvenor Wharf, Millbank, Westminster, Gentleman.

1847, Jan. 19th. [11622] John McIntosh, of London, Gentleman.

1847, Jan. 21st. [11623] George Beudon, of Taunton, in the County of Somerset, Commander in Her Majesty's Navy, and Andrew Smith, of Prince's Street, Leicester Square, Middlesex, Engineer.

1847, May 4th. [11770] Conrad Haverkum Greenhow, of North Shields, Gentleman.

1847, May 4th. [11771] William Henwood, of Portsea, in the County of Southampton, Naval Architect.

1847, May 4th. [11773] Gardner Stow, of King Street, Cheapside, Gentleman.

1847, May 6th. [11781] Johann Gottlob Seyrig, of New Lenton, in the County of Nottingham, Engineer.

1847, June 12th. [11832] Francis Bowis Stevens, of Hoboken, in the County of Hudson, in the State of New Jersey, in the United States of America, Engineer.

1847, June 22nd. [11849] John McIntosh, of Bedford Square, Middlesex, Gentleman.

1847, June 22nd. [11850] James Soutter, and William Frederick Hammon, of the Spread Eagle Works, Limehouse.

1847, July 23rd. [14899] Henry Samuel Rayner, of Ripley, in the County of Derby, Civil Engineer.

1847, July 29th. [11909] Stopford Thomas Jones, of Stamford Street, Surrey, Lieutenant in Her Majesty's Service.

1847, Sep. 6th. [11937] Henry Vint, of Saint Mary's Lodge, Colchester, Gentleman.

1847, Oct. 7th. [11970] Sir Samuel Brown, of Vanburgh Lodge, Blackheath, Kent, Knight of the Hanoverian Guelphic Order, and Captain in Her Majesty's Navy.

1847, Oct. 7th. [11973] Thomas Hunt Barber, of King Street, Cheapside, London, Gentleman.

1847, Oct. 14th. [11990] William Ayre, the younger, of the Borough of Kingston-upon-Hull, Attorney at Law.

1847, Nov. 2nd. [12020] Jean Charles Victor Coullon, of Auxerre, France, Boat Builder.

1847, Nov. 6th. [12030] James Pedder, of New Union Street, Middlesex, Engineer.

1848, Jan. 11th. [12104] Gardner Stow, late of King Street, Cheapside, but now of New York, in the United States of America, Gentleman.

1848, Feb. 8th. [12134] Robert Fowles, of North Shields, Northumberland, Gentleman.

1848, March 22nd. [12188] William James Dorley, of Lambeth, Surrey, Lithographer.

1848, April 4. [12192] James Pilbrow, of Tottenham, Middlesex, Engineer.

1848, May 4th. [12232] Felicite Raison Sellique, of No. 6, Boulevard Beaumarchais, Paris, Widow.

1848, May 26. [12246] Moses Poole, of the Patent Office, London, Gentleman.

1848, June 13th. [12267] John Miller, of Henrietta Street, Covent Garden, Gentleman.

1848, June 13th. [12269] Joshua Taylor Beule, of East Greenwich, in the County of Kent, Civil Engineer.

1848, July 11th. [12295] Jesse Ross, of Leicester, Agent.

FIG. 1.

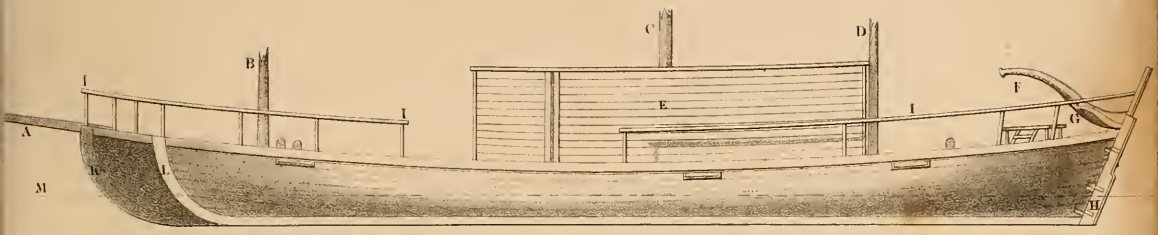


FIG. 2.

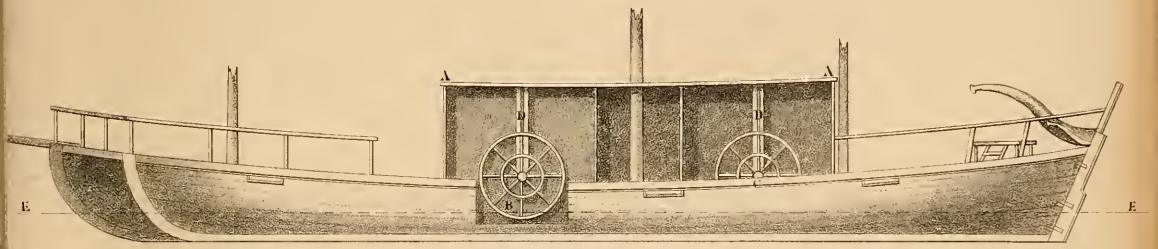
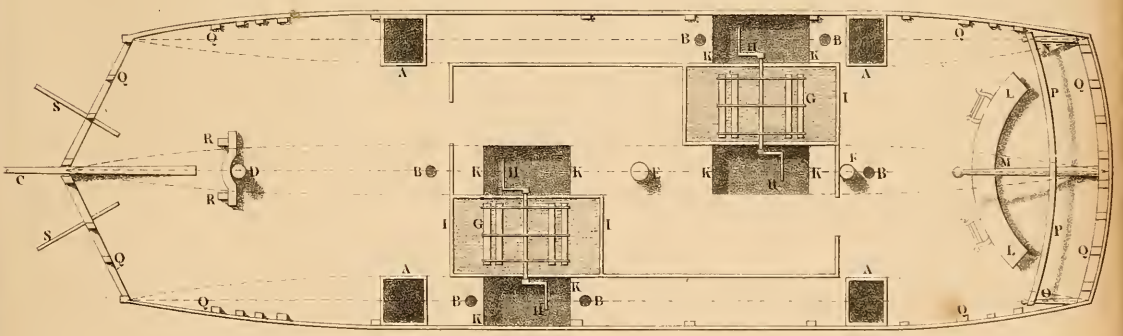


FIG. 3.



C.F. Chesshire, Lith. of London.

FIG. 4.

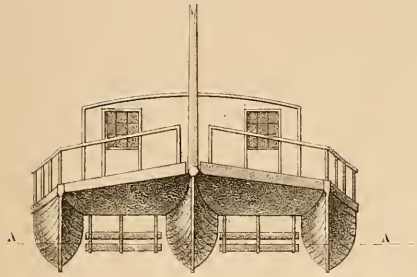
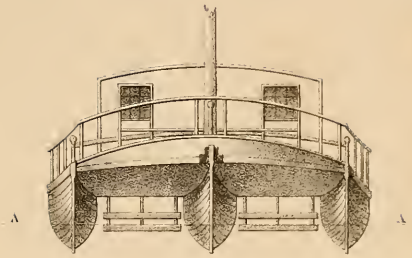


FIG. 5.



SCALE OF FEET

FIG. 8.

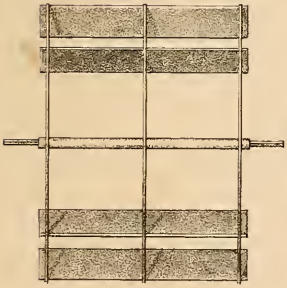


FIG. 9.

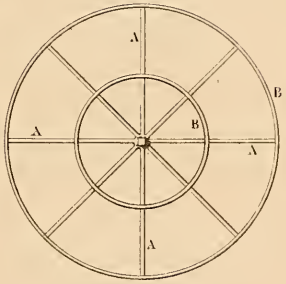
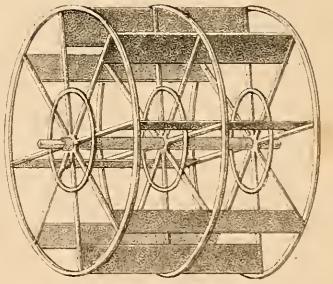


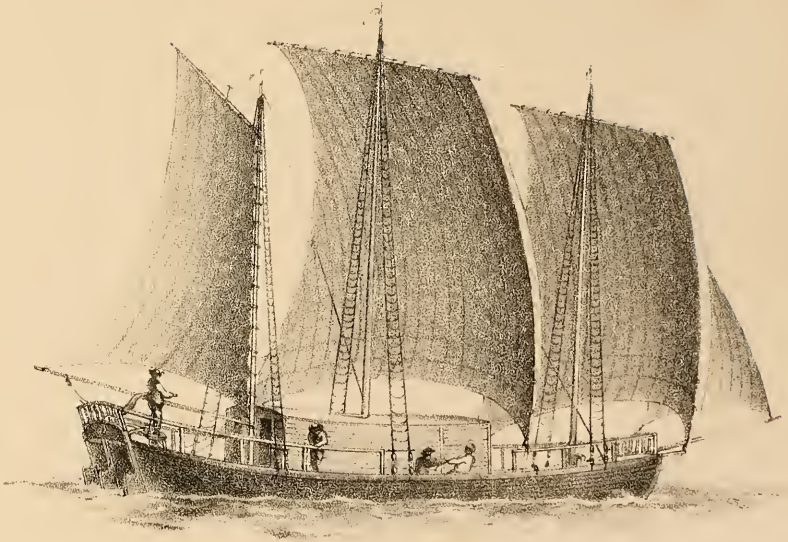
FIG. 10.



SCALE OF FEET FOR FIGS 8.9.10.

FIG. 7.

FIG. 6.



C.F. Cheffins, Lithog.

Drawn by J.C.Bourne.

C.F.Cheffins, Lithog.

DOUBLE SHIP.

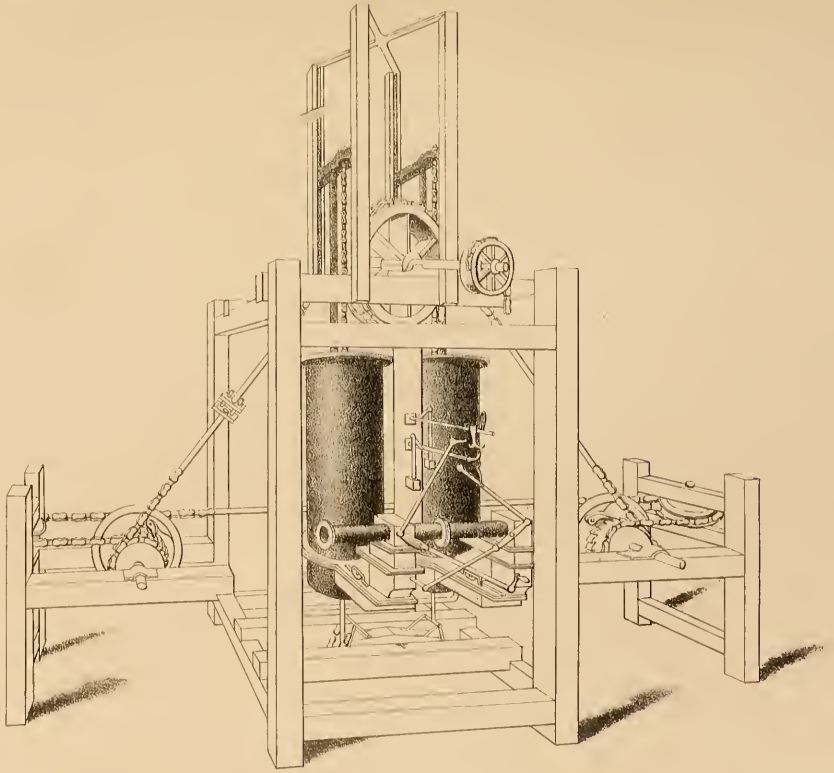
PATRICK, MILLAR, & Co.

Drawn by J.C.Bourne.

C.E.Cheffins, Lithog

DOUBLE PLEASURE BOAT.

WILLAM TAYLOR, SYMINGTON 1788



Drawn by H.B.Barlow. C.F.Cheffins lithog.

ENGINES OF THE DOUBLE PLEASURE BOAT.

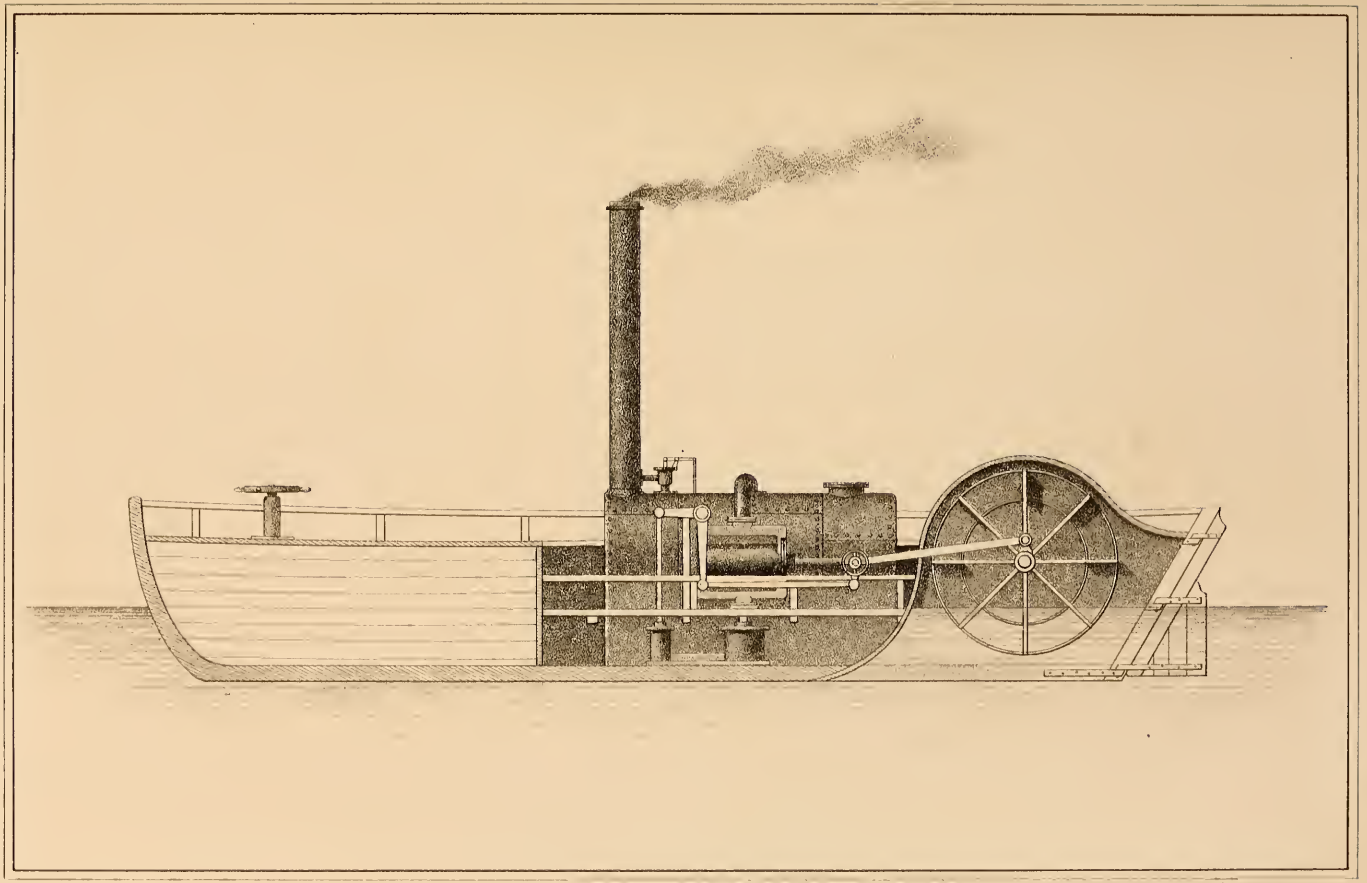
MILLAR. TAYLOR. SYMINGTON. 1788.

Drawn by J.C.Bourne.

C.F.Cheffins, Lithog.

THE CHARLOTTE DUNDAS.

WILLY SYMINGTON 1802.



Drawn by H.B.Barlow. C.F.Cheffins lithog.

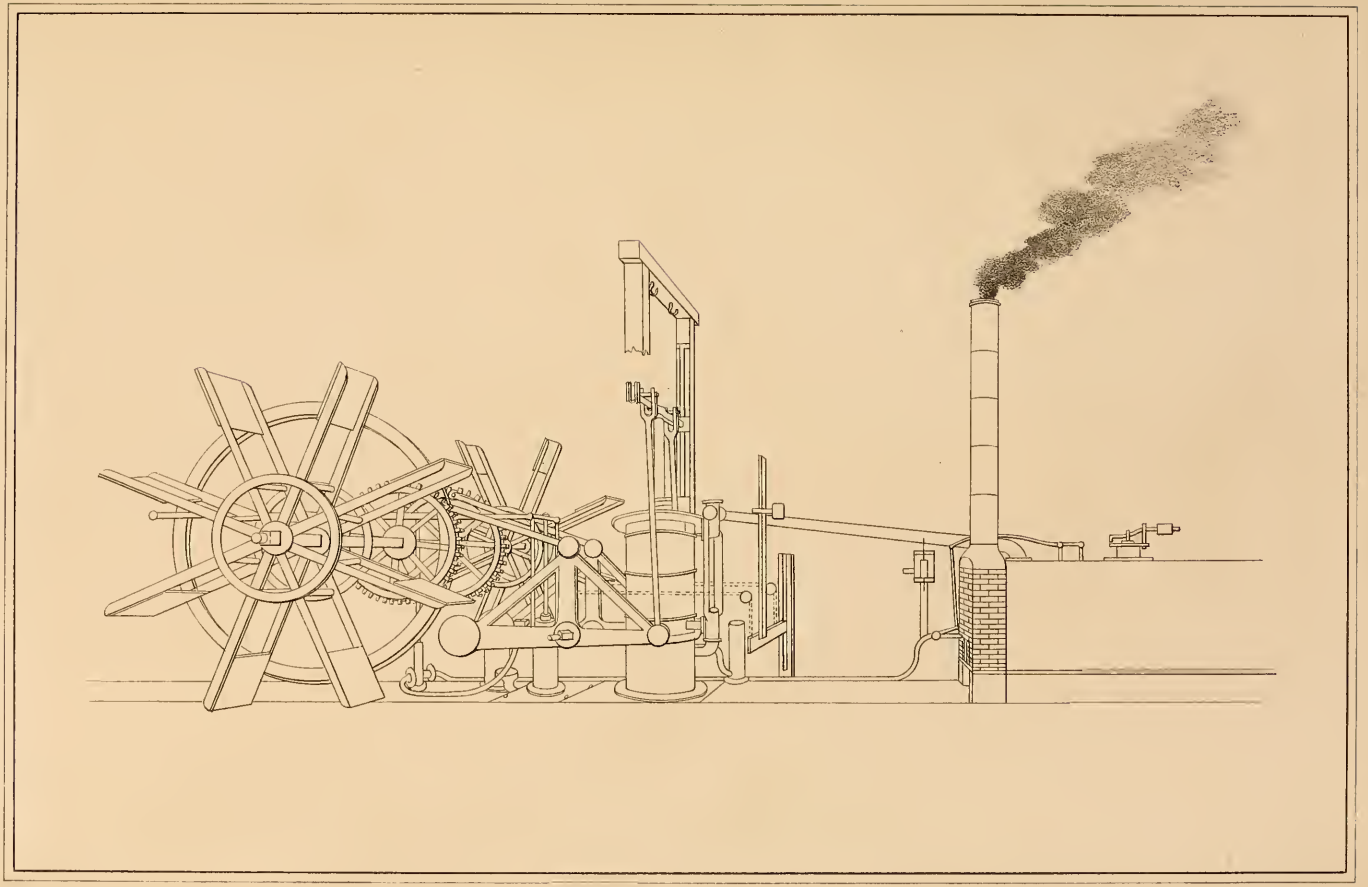
MACHINERY OF THE CHARLOTTE DUNDAS.

WILLIAM SYMINGTON. 1803.

Drawn by J.C.Bourne.

C.F.Chellins. Lithog

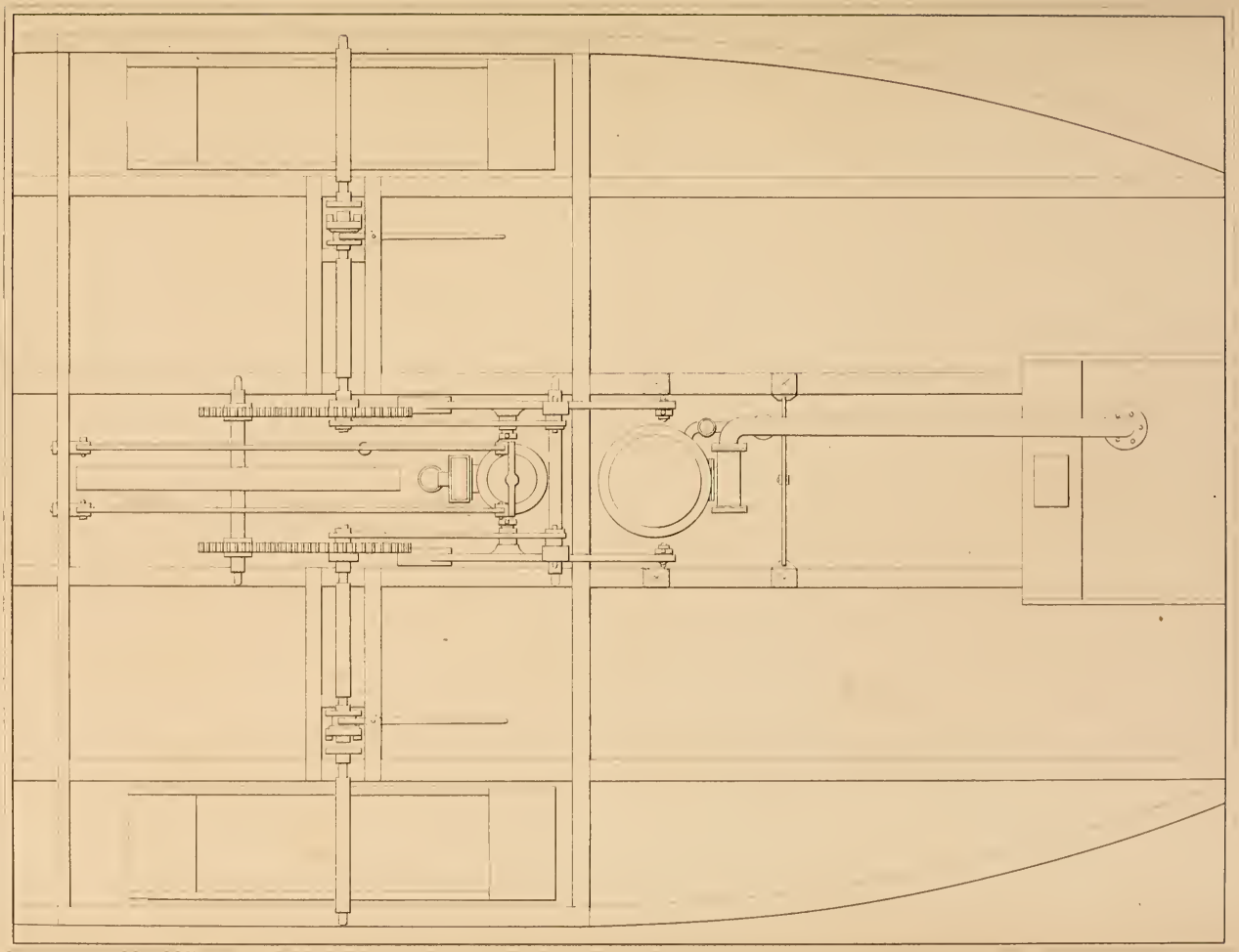
THE NORTH RIVER OR CLEREMONT



Drawn by H. B. Barlow.

C.F. Cheffins lithog.

PERSPECTIVE VIEW OF MACHINERY IN FULTON'S CLEREMONT. 1807.



Drawn by H.B.Barlow.

C.E.Cheffins lithog.

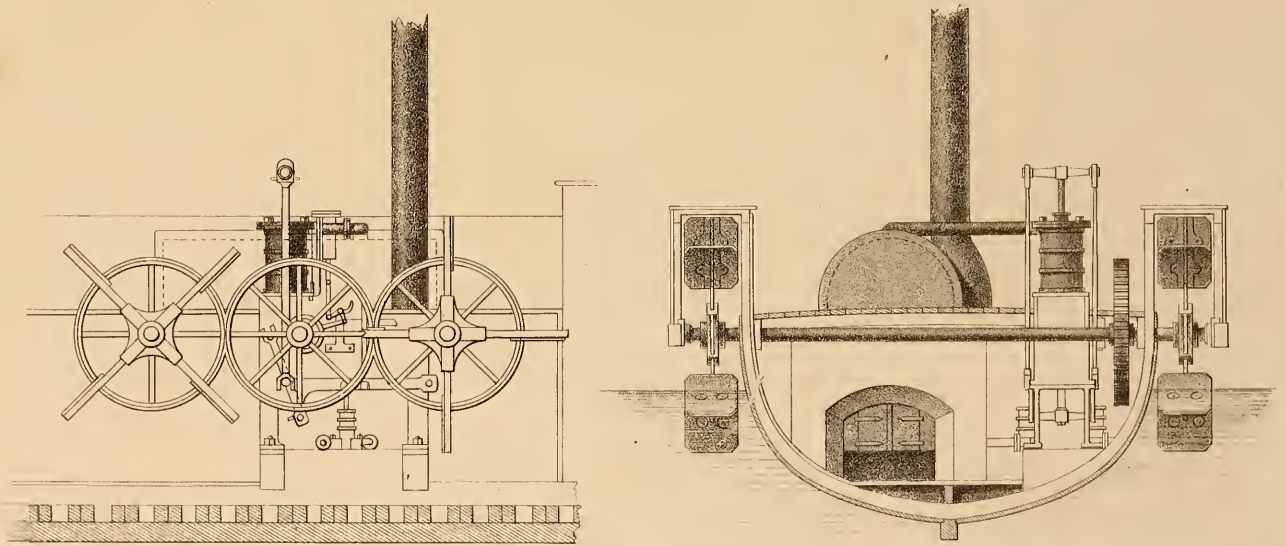
PLAN OF MACHINERY IN FULTON'S SPECIFICATIONS OF PATENT. 1809.

C.F.Cheffins, Lithog.

Drawn by J.C.Bourne.

THE COMET

HENRY BELL 1812



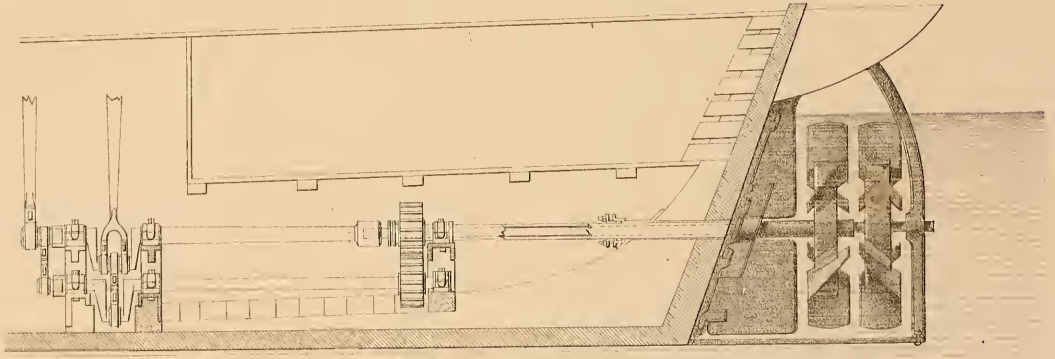
Drawn by R.B.Barlow.

C.F.Cheffins lithog.

ENGINE AND PADDLE WHEELS OF BELL'S COMET. 1812.

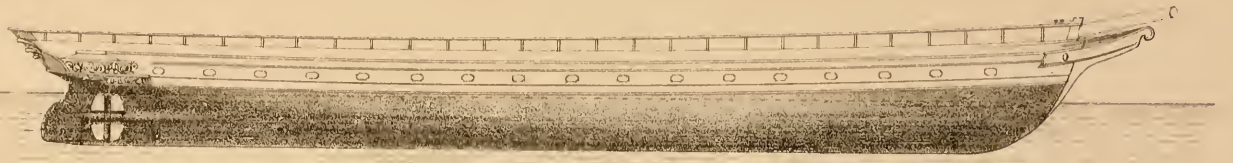
Drawn by J.C.Bourne.

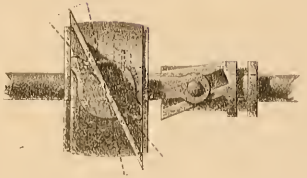
C.F.Cheffins, Lithog.

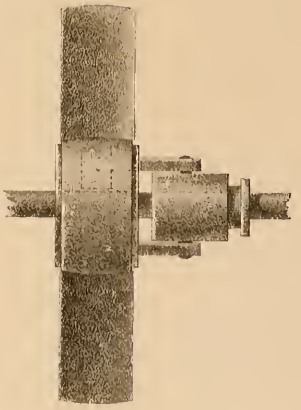


C.F. Cheffins lithog.

ERICSSON'S SCREW PROPELLERS IN THE ROBT F. STOCKTON. 1839.







Drawn by H.B.Barlow.

C.F.Cheffins lithog.

H.M.S.DWARF, WITH WOODCROFT'S PATENT *VARYING PITCH* SCREW PROPELLER.

1844.

Accession no.
JFF
Author
Woodcroft , B.
Steam navigation.
Call no. Hist.
VM
847W